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ABSTRACT

This self-study course is designed to familiarize Marine enlisted personnel with the principles of plumbing and sewage disposal used by Marine Hygiene Equipment Operators to perform their mission. The course contains three study units. Each study unit begins with a general objective, which is a statement of what the student should learn from the unit. The study units are divided into numbered work units, each presenting one or more specific objectives. Text is furnished, illustrated as needed, for each work unit. At the end of the work units are study questions, with answers listed at the end of the study unit. A review lesson completes the course. The three units of the course cover the following subjects: pipe and fittings, water service, and sewage systems. (KC)

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UNITED STATES MARINE CORPS
MARINE CORPS INSTITUTE
ARLINGTON, VA 22222-0001

IN REPLY TO

11.21a
27 Feb 86

1. ORIGIN

MCI course 11.21a, PLUMBING AND SEWAGE DISPOSAL, has been prepared by the Marine Corps Institute.

2. APPLICABILITY

This course is for instructional purposes only.

K. M. Kennedy

K. M. KENNEDY
Lieutenant Colonel, U.S. Marine Corps
Deputy Director

ACKNOWLEDGMENT

The Marine Corps Institute, Marine Barracks, Washington, D.C., gratefully acknowledges the important contributions provided by the following MCI personnel in developing and publishing this course:

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The Marine Corps Institute gratefully acknowledges the assistance of Marine Corps Engineer Schools, Marine Corps Base Camp Lejeune, North Carolina, in the formal review of this course.

INFORMATION
FOR
MCI STUDENTS

Welcome to the Marine Corps Institute training program. Your interest in self-improvement and increased professional competence is commendable.

Information is provided below to assist you in completing the course. Please read this guidance before proceeding with your studies.

1. MATERIALS

Check your course materials. You should have all the materials listed in the "Course Introduction." In addition you should have an envelope to mail your review lesson back to MCI for grading unless your review lesson answer sheet is of the self-mailing type. If your answer sheet is the pre-printed type, check to see that your name, rank, and social security number are correct. Check closely, your MCI records are kept on a computer and any discrepancy in the above information may cause your subsequent activity to go unrecorded. You may correct the information directly on the answer sheet. If you did not receive all your materials, notify your training NCO. If you are not attached to a Marine Corps unit, request them through the Hotline (autovon 288-4175 or commercial 202-433-4175).

2. LESSON SUBMISSION

The self-graded exercises contained in your course are not to be returned to MCI. Only the completed review lesson answer sheet should be mailed to MCI. The answer sheet is to be completed and mailed only after you have finished all of the study units in the course booklet. The review lesson has been designed to prepare you for the final examination.

It is important that you provide the required information at the bottom of your review lesson answer sheet if it does not have your name and address printed on it. In courses in which the work is submitted on blank paper or printed forms, identify each sheet in the following manner:

DOE, John J. Sgt 332-11-9999
08.4g, Forward Observation
Review Lesson
Military or office address
(RUC number, if available)

Submit your review lesson on the answer sheet and/or forms provided. Complete all blocks and follow the directions on the answer sheet for mailing. Otherwise, your answer sheet may be delayed or lost. If you have to interrupt your studies for any reason and find that you cannot complete your course in one year, you may request a single six month extension by contacting your training NCO, at least one month prior to your course completion deadline date. If you are not attached to a Marine Corps unit you may make this request by letter. Your commanding officer is notified monthly of your status through the monthly Unit Activity Report. In the event of difficulty, contact your training NCO or MCI immediately.

3. MAIL-TIME DELAY

Presented below are the mail-time delays that you may experience between the mailing of your review lesson and its return to you.

	TURNAROUND MAIL TIME	MCI PROCESSING TIME	TOTAL NUMBER DAYS
EAST COAST	16	5	21
WEST COAST	16	5	21
FPO NEW YORK	18	5	23
FPO SAN FRANCISCO	22	5	27

You may also experience a short delay in receiving your final examination due to administrative screening required at MCI.

4. GRADING SYSTEM

LESSONS			EXAMS	
GRADE	PERCENT	MEANING	GRADE	PERCENT
A	94-100	EXCELLENT	A	94-100
B	86-93	ABOVE AVERAGE	B	86-93
C	78-85	AVERAGE	C	78-85
D	70-77	BELOW AVERAGE	D	65-77
NL	BELOW 70	FAILING	F	BELOW 65

You will receive a percentage grade for your review lesson and for the final examination. A review lesson which receives a score below 70 is given a grade of NL (no lesson). It must be resubmitted and PASSED before you will receive an examination. The grade attained on the final exam is your course grade, unless you fail your first exam. Those who fail their first exam will be sent an alternate exam in which the highest grade possible is 65%. Failure of the alternate will result in failure of the course.

5. FINAL EXAMINATION

ACTIVE DUTY PERSONNEL: When you pass your REVIEW LESSON, your examination will be mailed automatically to your commanding officer. The administration of MCI final examinations must be supervised by a commissioned or warrant officer or a staff NCO.

OTHER PERSONNEL: Your examination may be administered and supervised by your supervisor.

6. COMPLETION CERTIFICATE

The completion certificate will be mailed to your commanding officer and your official records will be updated automatically. For non Marines, your completion certificate is mailed to your supervisor.

7. RESERVE RETIREMENT CREDITS

Reserve retirement credits are awarded to inactive duty personnel only. Credits awarded for each course are listed in the "Course Introduction." Credits are only awarded upon successful completion of the course. Reserve retirement credits are not awarded for MCI study performed during drill periods if credits are also awarded for drill attendance.

8. AMERICAN COUNCIL ON EDUCATION (ACE) ACCREDITATION

Many of MCI's MOS courses have been evaluated by ACE and determined to have equivalency credit in either the Vocational Certificate (VC) category or the Baccalaureate/Associate Degree (BA) level.

If you are enrolled in a college or vocational program or plan to enroll and have completed one or more MCI courses, you may be able to receive college or vocational credit for them. All that you need to do is to petition your school to see if they will award you credit for the courses that apply to your program area. You will need your completion certificate, and the Evaluation of Educational Experiences in the Armed Services.

9. DISENROLLMENT

Only your commanding officer can request your disenrollment from an MCI course. However, an automatic disenrollment occurs if the course is not completed (including the final exam) by the time you reach the CCD (course completion deadline) or the ACCD (adjusted course completion deadline) date. This action will adversely affect the unit's completion rate.

10. ASSISTANCE

Consult your training NCO if you have questions concerning course content. Should he/she be unable to assist you, MCI is ready to help you whenever you need it. Please use the Student Course Content Assistance Request Form (ISD-1) attached to the end of your course booklet or call one of the AUTOVON telephone numbers listed below for the appropriate course writer section.

Personnel/Administration/Corrections/Logistics Embarkation/Maintenance Management	288-3259
Communications/Electronics/Aviation/NBC/Intelligence	288-3604
Infantry	288-3611
Engineer/Motor Transport/Utilities	288-2275
Supply/Food Services/Fiscal	288-2285
Tanks/Artillery/Infantry Weapons Repair Assault Amphibian Vehicles	288-2290

For administrative problems use the UAR or call the MCI HOTLINE: 288-4175

For commercial phone lines, use area code 202 and prefix 433 instead of 288.

MARINE CORPS INSTITUTE STUDY GUIDE

Congratulations for enrolling in the Marine Corps Institute's correspondence training program! By enrolling in this program, you have shown a desire to improve the skills you need to enhance your on-the-job performance.

Since 1920, MCI has been helping tens of thousands of hard-charging young Marines, like yourself, achieve educational goals by teaching necessary new skills or reinforcing existing skills. MCI will do every thing possible to help you reach your individual goals, whatever they may be.

Before you begin your course of instruction, you may be asking yourself, "How much will I benefit from a correspondence training program?" The answer to this depends upon you, *"YOUR PROFESSIONAL TRAITS"* (what you bring to the learning situation).

Because you have enrolled in an MCI course, your professional traits are evident and we know that:

YOU ARE PROPERLY MOTIVATED. You made a positive decision to get training on your own. Self-motivation is perhaps the most important force in learning-or achieving—anything. Wanting to learn something badly enough so that you will do what's necessary to learn—*THAT IS MOTIVATION.*

YOU SEEK TO IMPROVE YOURSELF. You enrolled to learn new skills and develop special abilities.

YOU HAVE THE INITIATIVE TO ACT. By acting on your own, you have shown that you are a self-starter, willing to reach out for opportunities.

YOU ACCEPT CHALLENGES. You have self-confidence and believe in your ability to gain training in your areas of interest.

YOU ARE ABLE TO SET PRACTICAL GOALS. You are willing to commit time, effort, and resources toward accomplishing what you set out to do. These professional traits will help you achieve success in your MCI program.

To begin your course of study:

* Look at the course introduction page. Read the COURSE INTRODUCTION to get the "nitty gritty" of what the course is about. Then read the MATERIALS section near the bottom of the page to find out which text(s) and study aids you should have received with the course. If any of the listed materials are missing, see *Information for MCI Students* to find out how to obtain them. If you have everything that is listed, you are ready to begin your MCI course.

* Read through the *TABLE OF CONTENTS* of your text(s). Note the various subjects covered in the course and the order in which they are taught. Leaf through the text(s) and look at the illustrations. Read a few work unit exercise questions to get an idea of the types of questions that are asked. If MCI provides other study aids, such as a slide rule or a plotting board, familiarize yourself with them. Now, you are ready to begin work on your MCI course.

* Turn to the first page of study unit 1. On this page you will find the study unit goal. This is a statement of what you should be able to do when you complete the final exam. Each study unit is divided into work units. Each work unit contains one terminal learning objective and several enabling objectives. The terminal learning objective is what you should be able to accomplish when you complete the work unit exercises. The enabling objectives are the steps you need to learn to help you accomplish the terminal learning objective. Read each objective for the work unit and then read the work unit text carefully. Make notes on the ideas you feel are important.

* Without referring to the text, answer the questions in each exercise.

* Check your answers against the correct ones listed at the end of the study unit.

* If you miss any of the questions, restudy the work unit until you understand the correct response.

* Go on to the next work unit, repeating the above steps, until you have completed all the work units in the study unit.

* Follow the same procedure for each study unit of the course. If you have problems with the text or work unit questions that you cannot solve on your own, ask your training NCO for the name of someone who can help you. If they cannot aid you, request assistance from MCI on the Student Course Content Assistance Request included with this course, or refer to your INFORMATION FOR MCI STUDENTS (MCI-R24i-NRL) for the telephone number of the appropriate Course Developing Division at MCI.

* When you have finished all the study units, complete the course review lesson. Try to answer each question without the aid of reference materials. However, if you do not know an answer, look it up. When you have finished the review lesson, take it to your training officer or NCO for mailing to MCI. MCI will grade it and send you a feedback sheet (MCI-R69) with your final examination listing course references for any questions that you missed on the review lesson.

"RECON" Reviews:

To prepare for your final examination you *must* review what you learned in the course. Therefore, why not make reviewing as interesting as possible. The following suggestions will make reviewing not only interesting but also a challenge.

1. Challenge yourself. Reconstruct the learning event *in your mind.* Try to recall and recapture an entire learning sequence, without notes or other references. Can you do it? You just have to "look back" to see if you've left anything out, and *that* will be an interesting read-through (review) for you.

Undoubtedly, you'll find that you were not able to recall everything. But with a little effort you'll be able to recall a great deal of the information.

Also, knowing that you are going to conduct a "reconstruct-review" will change the way you approach your learning session. You will try to learn so that you will be able to "reconstruct the event."

2. Use unused minutes. While waiting at sick bay, riding in a truck or bus, living through field duty, or just waiting to muster—use these minutes to review. Read your notes or a portion of a study unit, recalculate problems, do self-checks a second time; you can do many of these things during "unused" minutes. Just thinking about a sequence of instruction will refresh your memory to help "secure" your learning.

3. Apply what you've learned. Always, it is best to do the thing you've learned. Even if you cannot immediately put the lesson to work, sometimes you can "simulate" the learning situation. For example, make up and solve your own problems. Make up problems that take you through most of the elements of a study unit.

4. Use the "shakedown cruise" technique. Ask a fellow Marine to lend a hand and have him ask you questions about the course. Give him a particular study unit and let him fire away. It can be interesting and challenging.

The point is, reviews are necessary for good learning, but they don't have to be long and tedious. Several short reviews can be very beneficial.

Semper Fi

PLUMBING AND SEWAGE DISPOSAL

Course Introduction

PLUMBING AND SEWAGE DISPOSAL is designed to familiarize the student with the principles of plumbing and sewage disposal used by Marine Hygiene Equipment Operators to perform their mission.

ADMINISTRATIVE INFORMATION

ORDER OF STUDIES

Study Unit Number	Study Hours	Subject Matter
1	5	Pipe and Fittings
2	4	Water Service
3	3	Sewage Systems
	2	REVIEW LESSON
	2	FINAL EXAMINATION
	16	

- -

RESERVE RETIREMENT CREDITS:	5
EXAMINATION:	Supervised final examination without text or notes with a time limit of 2 hours
MATERIALS:	MCI 11.21a, Plumbing and Sewage Disposal, review lesson and answer sheet.
RETURN OF MATERIALS:	Students who successfully complete this course are permitted to keep the course materials. Students disenrolled for inactivity or at the request of their commanding officer will return all course materials.

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SOURCE MATERIALS

TM 5-551K	Plumbing and Pipefitting, July 71
NAVEDTRA 10661 Vol 1 and 2	Utilitiesman 3 & 2, Revised 1983

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HOW TO TAKE THIS COURSE

This course contains 3 study units. Each study unit begins with a general objective that is a statement of what you should learn from the study unit. The study units are divided into numbered work units, each presenting one or more specific objectives. Read the objective(s) and then the work unit text. At the end of the work unit are study questions that you should be able to answer without referring to the text of the work unit. After answering the questions, check your answers against the correct ones listed at the end of the study unit. If you miss any of the questions, you should restudy the text of the work unit until you understand the correct responses. When you have mastered one study unit, move on to the next. After you have completed all study units, complete the review lesson and take it to your training officer or NCO for mailing to MCI. MCI will mail the final examination to your training officer or NCO when you pass the review lesson.

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STUDY UNIT 1

PIPE AND FITTING

STUDY UNIT OBJECTIVE: WITHOUT THE AID OF REFERENCES, YOU WILL IDENTIFY THE APPLICATION AND AVAILABILITY OF DIFFERENT TYPES OF PIPE USED BY THE MARINE CORPS. YOU WILL ALSO IDENTIFY SOME OF THE TERMS, TOOLS AND INSTALLATION TECHNIQUES ASSOCIATED WITH THESE PIPES AND DIFFERENT TYPES OF FITTINGS.

The Marine plumber is very much like his civilian counterpart. He uses basically the same tools, materials, and procedures. At times, the Marine plumber may have to use field expedients or "make do" until permanent installations are built because of the military situation. This course is designed for a Marine (Pvt through Cpl) who has had no prior field experience in plumbing and sewage disposal.

The MOS of Marine Corps Hygiene Equipment Operator is 1171. This MOS covers all the qualifications needed to install, operate, maintain, and repair plumbing, sewer, and water supply equipment and materials.

The Marine plumber's mission is to provide potable (drinkable) hot and cold water to installations by a piping system and then to remove the waste and liquid from these installations by a piping system to an area where it can be treated or disposed of. This piping must conform to certain codes and must be tight and waterproof. Care must be taken to insure that unpurified water does not get into the potable water supply.

This course will cover the tools, materials, and procedures necessary to acquaint Marine plumbers with the basic skills needed to perform his mission. The Marine's newly acquired skills in the plumbing field will be refined and his knowledge will be expanded through experience and working with more proficient people, thus enabling him to perform his job efficiently and to advance in his field.

Work Unit 1-1. IRON AND STEEL PIPE

IDENTIFY THE APPLICATION AND AVAILABILITY OF IRON AND STEEL PIPE.

IDENTIFY THE WEIGHTS AND USE OF IRON AND STEEL PIPE.

IDENTIFY THE TOOLS USED TO CUT, REAM, AND THREAD IRON AND STEEL PIPE.

STATE THE MATERIALS AND TOOLS USED TO INSURE A TIGHT FIT WHEN JOINING PIPE.

IDENTIFY THE MOST COMMON TYPES OF THREADED FITTINGS AND VALVES USED WITH IRON AND STEEL PIPE.

IDENTIFY THE MOST COMMON TYPES OF THREADED PIPE TRAPS.

Although iron pipe is not normally used in the Marine Corps in new installations, it WILL be found in many older installations. Steel pipe is still used in certain situations and is available in black or galvanized (as is iron pipe). One of the reasons that iron or steel pipe is not often used now is that these pipes can be difficult to join in tight places. A wrench must be used with the threaded fittings and sometimes there is not enough room to work the wrench. Also iron and steel pipe are very expensive. It is recommended that iron and steel pipe not be buried in the ground or set in concrete. For simplicity's sake, all pipe mentioned in this study unit will be termed iron instead of referring to it as a specific type, i.e., wrought iron or black or galvanized steel.

Over the last few years there has been a gradual phase-out of iron pipe from the Marine Corps, although it can still be ordered when there is a need. The Marine Corps aquires iron pipe in 21 foot lengths only, threaded and unthreaded. The size of iron pipe is measured by its inside diameter (I.D.). Pipe sizes available are 1/8 inch I. D. and larger. From 1/8 inch to 1 inch, the sizes are broken down in 1/8 inch increments. The next available sizes are 1, 1-1/4, 1-1/2, and 2 inches. The larger sizes are 2, 2-1/2, 3, 3 1/2, 4, 5, 6, 8, 10, and 12 inches.

Iron pipe has long been used in applications that require strength and durability. In some applications where vibrations are severe and pressures are high, only iron pipe can be used. With the advances in plastics and other metals, iron pipe has been replaced in all but a few specific applications.

The **cold water distribution system** is that part of the plumbing system that supplies potable water to a building or installation from a water source. In the following study units more details of the requirements of a cold water supply will be discussed. Iron piping, used for many years in the cold water distribution system, was replaced by galvanized steel because it could better withstand the corrosive effects of water and of being in the earth. In the late 1940's copper was phased in and was used predominantly until plastic pipe was introduced. (Copper and plastic are less affected by corrosion than iron and steel.)

The **hot water distribution system** is that part of the plumbing system which heats water and distributes it to various fixtures. The hot water system usually runs parallel (no closer than 6 inches) to the cold water distribution system. For many years iron pipe was used for this piping because it was the only material that could withstand the higher temperatures and pressure. Now, although copper and plastic are in use in many applications, there are still many applications where only the strength and durability of iron or steel pipe are trusted. For example, high temperature, high pressure steam systems are normally installed with iron piping. Gas and air piping systems also use iron and steel piping.

As a Marine plumber, you can expect at times to work on both **gas and air piping systems.** Gas is often used for heating and cooking. Any time that you need to pipe a gas that is poisonous or is capable of creating explosive fumes, you must insure that your piping is strong and without leaks. In these specific cases, iron pipe is the type of piping which is most often used. Iron pipe is also used a great deal in air systems that are under pressure such at those used in maintenance shops.

Iron pipe has been used in drainage and vent installations because it is generally cheaper and easier to use than cast iron pipe. However, iron pipe is not as durable as cast iron pipe, so in this situation its use is not generally recommended.

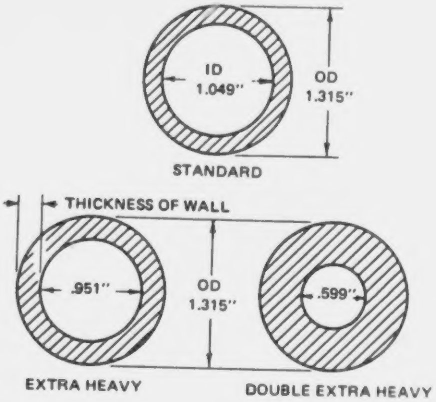

Fig 1-1. Pipe weights.

The **"weight"** of the pipe (determined by its thickness) is the term used to tell you the strength of a pipe. Pipe that carries a fluid under high pressure requires a stronger pipe than a water line. Figure 1-1 shows the **standard**, **extra heavy**, and **double extra heavy** pipe and the differences in their thicknesses.

Note: In figure 1-1 the outside diameter of the pipe stays the same as the thickness of the pipe becomes greater.

The standard weight pipe is often used by the Marine plumber as it is suited for most Marine Corps applications. Since this pipe is lighter or less thick, it is less expensive. The extra strong weight pipe is used mostly in commercial applications where there is a need for more strength than supplied by the standard weight pipe. Double extra heavy type of pipe is used in the most critical applications where there is a need for maximum strength. This pipe is primarily used for industrial purposes.

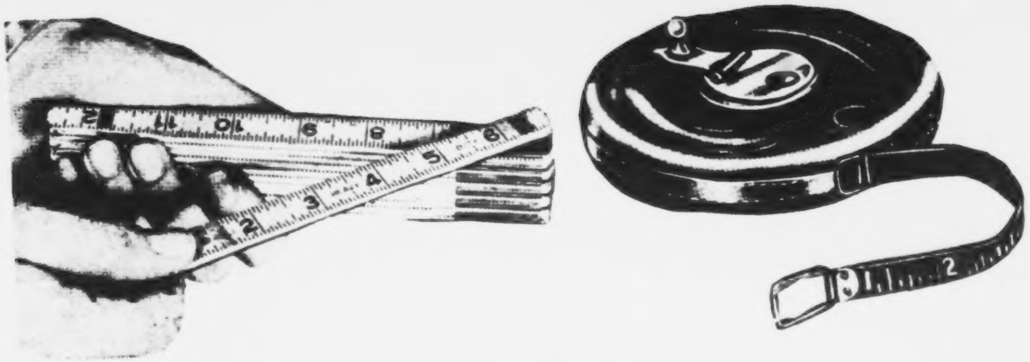

Fig 1-2. Rule and tape.

The cutting of iron pipe is a simple procedure if you have the proper tools and a little know-how. Accurate measurements are most important in piping procedures. Since the measuring tools (fig 1-2) will be subject to heavy use (as are all plumbing tools), a folding 6-foot steel rule and a steel measuring tape are recommended over measuring devices made of other materials.

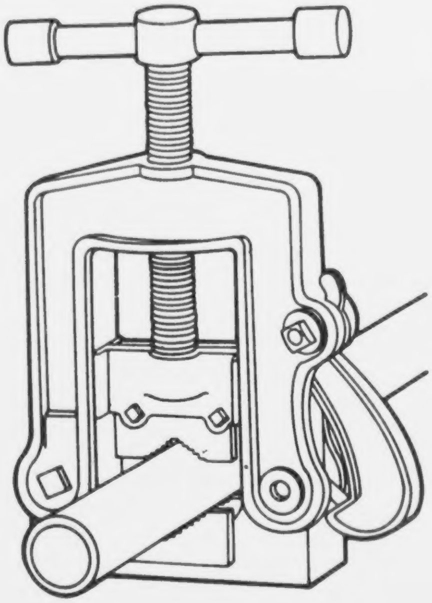

Fig 1-3. Self-locking pipe vise.

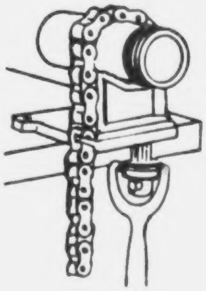

Fig 1-4. Chain vise.

The importance of a clean, even, flat cut cannot be overstated. To obtain this cut, the length of pipe to be cut must be anchored firmly. A pipe vise is used for this purpose. The most common type of pipe vise is shown in figure 1-3. It is called a self-locking pipe vise. The self-locking pipe vise is the best type of vise to use because it can accommodate many sizes of pipe and holds the pipe firmly. This type of vise should be anchored to a strong, heavy bench. Another type of pipe vise is the chain vise shown in figure 1-4. The chain vise can accommodate large size pipe, but does not hold small pipe firmly. The combination vise (fig 1- 5) is used primarily for short pieces of pipe. On long pipe, because of the way the vise is made and anchored to the bench, the long piece of pipe will hang and prevent the pipe from being firmly anchored.

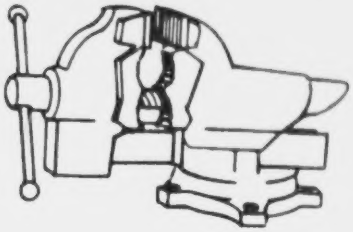

Fig 1-5. Combination vise.

All of the above pipe vises must be anchored firmly to work benches. A vice that is not shown is the self-supported vise. This vise has supporting legs and a platform.

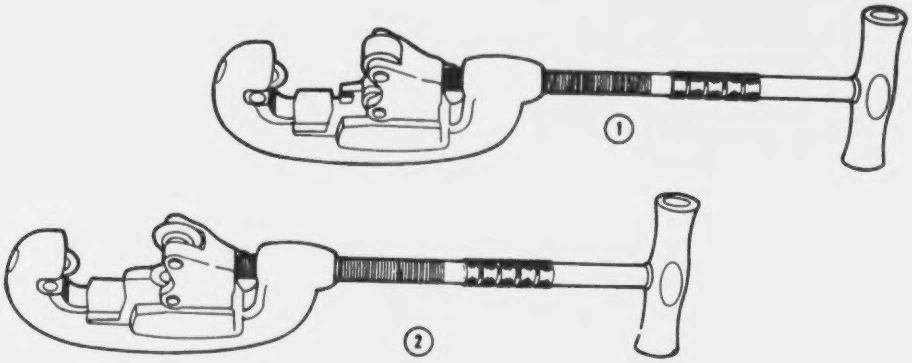

Fig 1-6. Wheel type of pipe cutter.
1. Single wheel cutter.
2. Three wheel cutter.

A wheel type of pipe cutter is used to cut iron pipe. Figure 1-6 shows a typical wheel type of pipe cutter. A hacksaw can be used to cut iron pipe but this is not recommended because it will take longer and the cut is not usually square.

A pipe that has been measured and marked with chalk or pencil is placed in a pipe vise so that the measured mark extends approximately 8 inches out from the vise. The pipe cutter is put on the pipe from the underside of the pipe so that the cutting wheel can be placed on the measured mark. (Insure that there are no nicks or burrs on the cutting wheel.) The handle is tightened slightly and then the pipe cutter is revolved completely around the pipe. After every revolution, tighten the handle approximately 1/4 turn but not so much that it squeezes the pipe and reduces its diameter excessively. Cutting and threading oil should be used to lubricate the pipe cutter. Cutting and threading oil is discussed later in the threading material paragraph.

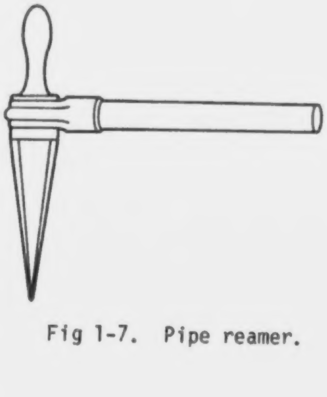

Fig 1-7. Pipe reamer.

When a piece of pipe is cut, the inside diameter of the pipe is reduced somewhat and burrs are formed on the inside of the cut portion. These burrs must be removed by reaming so that the flow of liquids will not be restricted when the pipe is joined. A pipe reamer such as the one illustrated in figure 1-7 is used for this purpose.

The reamer has spiraled cutting edges shaped like a cone. The reamer is pushed squarely into the pipe and turned clockwise in quarter revolutions until the excess metal is removed from the inside of the pipe.

The threading process is probably the most important part of working with iron pipe. Without proper threads, leaks will occur at the joints. Leaks occurring on a plumbing job are most embarrassing to the plumber and can result in a needless waste of our energy resources.

The tool needed to thread iron pipe is expensive and has to be treated with care in order for it to have a long life. This tool is called a pipe threader. It consists of two basic parts, a die stock and a die.

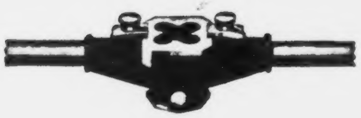

Fig 1-8. Pipe threader (two-handled non-ratchet) die stock with die).

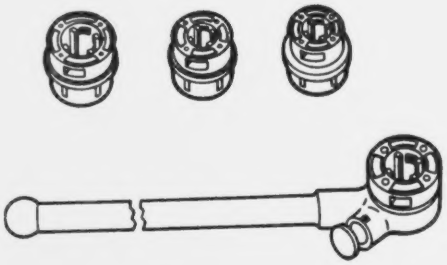

Fig 1-9. One handled (ratchet) die stock.

The die stock serves as the housing or holder for the die, which actually cuts the grooves or threads into the pipe. The die stock is rotated around a piece of pipe and, while it is turning, the die is threading the pipe. The simpler units have a single longhandle, while some other models have built-in ratchet mechanisms. Others have two handles to aid turning. Figure 1-8 shows a two-handled, non-ratchet type die stock with a die. Figure 1-9 shows a one-handled ratchet type die stock. You will have access to both types of die stocks in the Marine Corps.

The die is the actual tool that cuts the thread into the pipe. The light colored portion between the two holding screws in figure 1-8 is the actual die. A certain size die must be used for a given size pipe. In the Marine Corps, you will be able to thread pipe with an I.D. of 1/8 inch to 2 inches with the tools readily available to you.

Threading oil or cutting oil is used to lubricate the die during threading operations. A pure, strained lard oil is a good lubricant. There are many good trade names on the market; other than lard oil, a good threading oil or cutting oil will have a sulfur base.

Assuming that all the earlier procedures discussed pertaining to measuring, securing the pipe in a vise, and cutting and reaming have been accomplished, then the threading procedures can be started. Select the proper size die (each die is marked) and slip it into place inside the die stock. Be sure you insert it so the larger opening will slip over the end of the pipe first. After the die and its guide (if it has one) are in place, tighten the lockscrew or thumb nut that holds the die in the die stock.

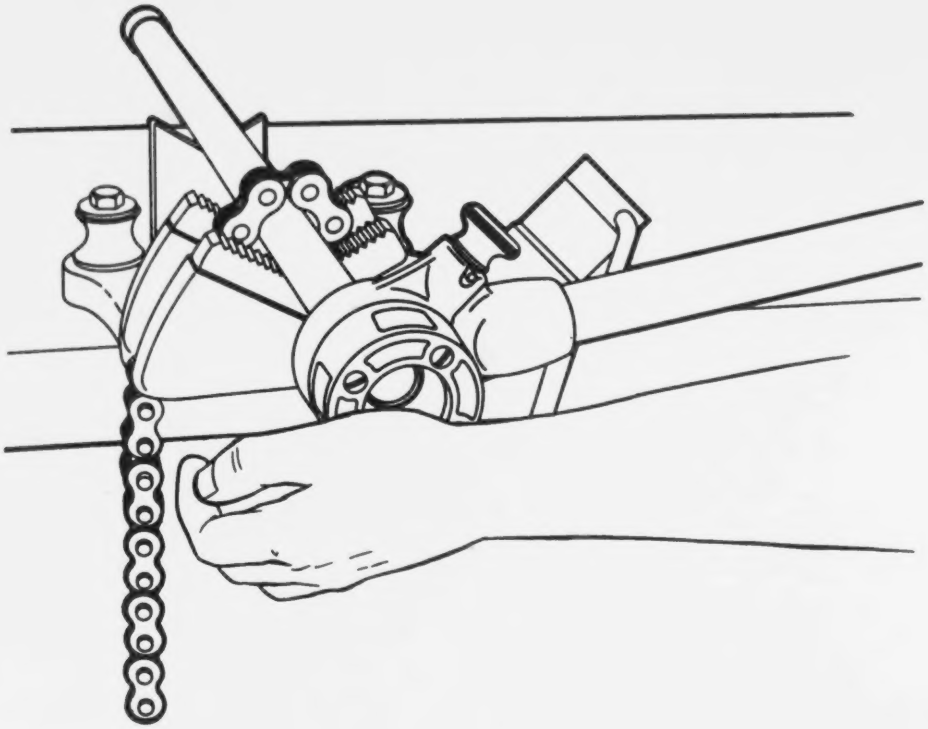

Fig 1-10. Threading pipe.

Position the die slowly onto the pipe (the guide should slip over pipe first) and turn the stock handle gently in a clockwise direction until you feel the die threads biting into the pipe. Maintain steady pressure on the pipe threader with the heel of one hand as illustrated in figure 1-10. Keep turning the stock in a clockwise direction until at least one full thread has been cut. Then use an oil can to apply cutting oil liberally to both the inside of the die and the outside of the pipe as you cut the threads. After each full turn forward, back off about 1/4 of a turn in order to clear away any accumulation of metal chips, then apply more cutting oil. (It is important to keep the die well lubricated at all times.)

Continue threading until the end of the pipe projects about 1/4 to 1/2 inch from the die end of the stock. When you've gotten this far, turn it counterclockwise to unscrew the die from the threaded end. Ratchet stocks have a reversing mechanism which will enable you to back off the threads. Finally, remove the die carefully so that you do not damage the threads. Wipe off all surplus oil and metal chips before using the pipe.

Leaks cannot be tolerated in a plumbing installation. Certain basic procedures must be carried out to join iron pipe properly. What we have discussed so far, measuring, cutting, and threading, have been preparatory steps. Now we will discuss the procedures used to "join" pipe.

When installing a new series of pipe and fittings (sometimes referred to as a run of pipe) or cutting into an old series and putting in a new piece of pipe, precise measurements are required. If precise measurements are not made, then the pipe will not fit correctly. The pipe may be too long and you might try to force it into place or it may be too short and you might try to back off (or unthread) a fitting at one end to make it fit on the other end. This is not recommended and should not be done. This type of workmanship invites leaks and future problems. The following are terms used in measuring pipe and figure 1-11 shows the actual threaded pipe measurements. Refer to figure 1-11 for a pictorial view of the measurements.

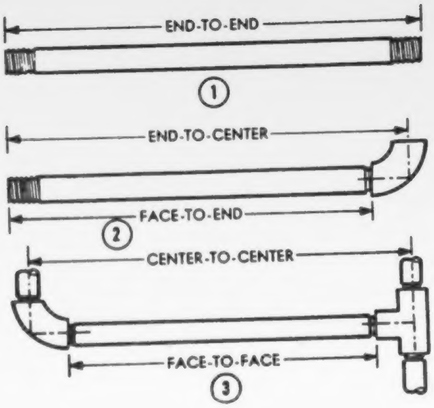

Fig 1-11. Threaded pipe measurements.

- End-to-end measure: This is the full length of the pipe including both threads.
- End-to-center measure: This is used when a fitting is on one end of the pipe. The measurement is from the threaded end to the center of the fitting on the other end.
- Face-to-end measure: This is the measurement from the threaded end to the fitting on the other end of the pipe.
- Center-to-center measure: This is used when a piece of pipe has a fitting on each end. This measurement is from the center of one fitting to the center of the other.
- Face-to-face measure: This is used when a piece of pipe has a fitting at each end. The measurement is from the face of one fitting to the face of the other fitting.

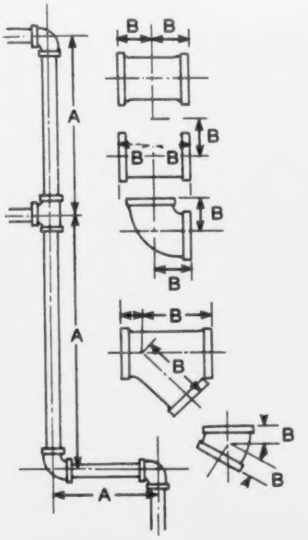

Fig 1-12. Determining the length of pipe in runs.

Each size pipe should be threaded into a fitting only for a certain distance. Center-to-center measurements are probably the most frequently used in determining the length of a pipe to be installed. Figure 1-12 shows a run of pipe with some center-to-center measurements marked A. The center-to-center measurement is the distance from the center of one fitting on one side of your pipe run to the center of the fitting on the other side of your run.

Note: The length of the pipe to be installed will always be smaller then the center-to-center measurement. This is because the pipe cannot be screwed all the way into the center of the fitting.

Figure 1-12 also shows some fittings which are drawn so that you can see the distance from the center of the fitting to one edge (B). When measuring pipe, consider the measurements of fittings at both ends of the pipe. Finally, figure 1-12 shows different pipe sizes and the distance that each pipe size is screwed into the fitting. The procedure to follow in determining the length of pipe that is needed between two fittings is as follows (refer to fig 1-12):

Step 1. Determine the length of the center-to-center measurement (dimension A).

Step 2. Determine the distance from the center of the fitting to one edge (dimension B) and subtract this amount from the A measurement.

Note: If the pipe is going to be joined into two fittings, you must subtract the B dimension at both ends of the pipe.

Step 3. Determine from the chart in figure 1-12 the distance the pipe you are using should be screwed into the fitting(s). Be sure to consider both ends. All you have to do now is add this distance to the measurement that you determined using steps 1 and 2. You now have the length of pipe needed for the installation.

Let us try a few sample calculations. Referring to A in figure 1-12, if the length of A is 2 feet and the B dimension is 1 inch and we are using 3/4 inch pipe, what is the length of pipe required? Work out your answer and then read on for an explanation. Answer: first, change the 2 feet to 24 inches. Second, subtract the B dimension (1 inch) from your A dimension (two ends to be screwed into fittings makes the B dimension a total of 2 inches) or 24 inches minus 2 inches = 22 inches. You are using 3/4 inch pipe and you know from figure 1-12 that the depth that 3/4 inch pipe is screwed into the fitting is 1/2 inch. (Two ends of pipe make this depth a total of 1 inch.) Now all that you have to do is add this 1 inch that the pipe is screwed into the fitting to the 22 inches (22 inches + 1 inch = 23 inches) and you have the length of pipe needed for this installation.

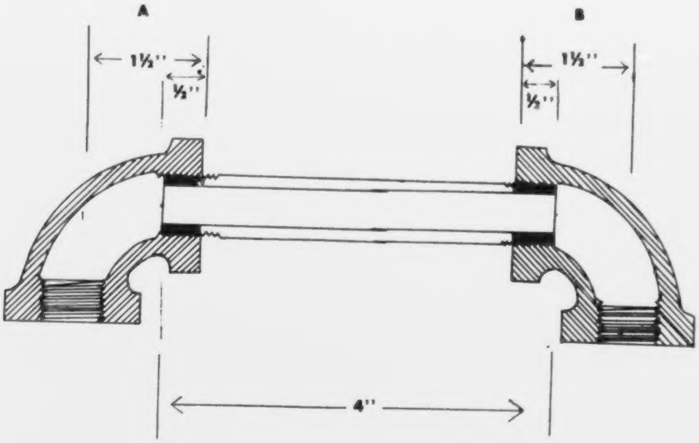

Fig 1-13. Sample length of pipe.

When making joints (assembling pipe), pipe "dope" should be applied to all male threads before screwing them into the fitting. "Dope" is the name given to the material which is applied to the threads by plumbers. This "dope" actually serves two purposes. It helps seal the joint to make a water-tight connection and it keeps fittings from "freezing" (rusting tight) shut so they can be removed later if repairs become necessary.

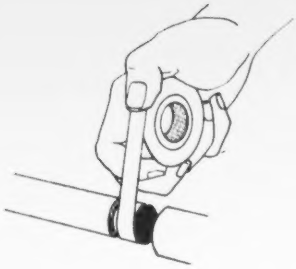

Fig 1-14. Applying pipe dope tape.

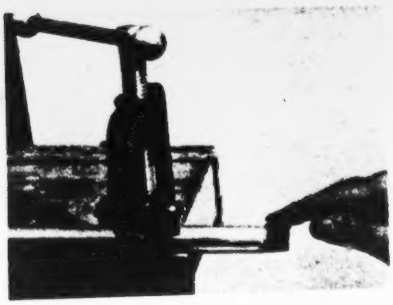

Fig 1-15. Applying pipe dope compound.

Antiseize/teflon, made of vinyl, is available in rolls similar to friction tape. Figure 1-14 shows this tape being applied to pipe threads. Tape is applied in a clockwise direction on the threads so that when the pipe or fitting is turned, the tape will be drawn and tightened in. Be careful that the tape does not extend into the opening of the pipe as this could cause a restriction.

Pipe dope compound is a putty-like substance which has a linseed oil base and is available in cans. It is usually applied with the finger on smaller diameter pipes (fig 1-15) and rubbed well into the male threads. Be careful not to get the compound in the pipe opening as this may form an obstruction.

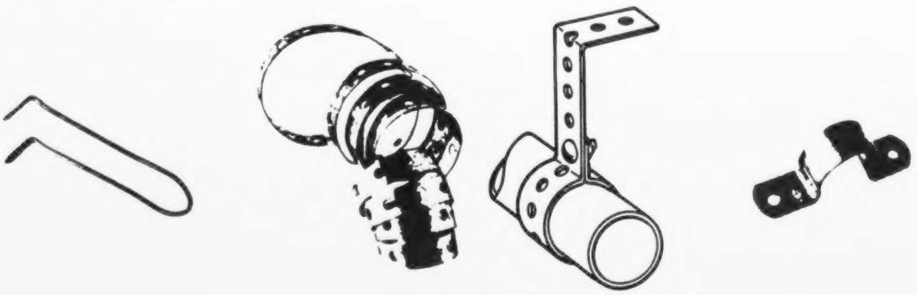

Fig 1-16. Typical overhead pipe hangers.

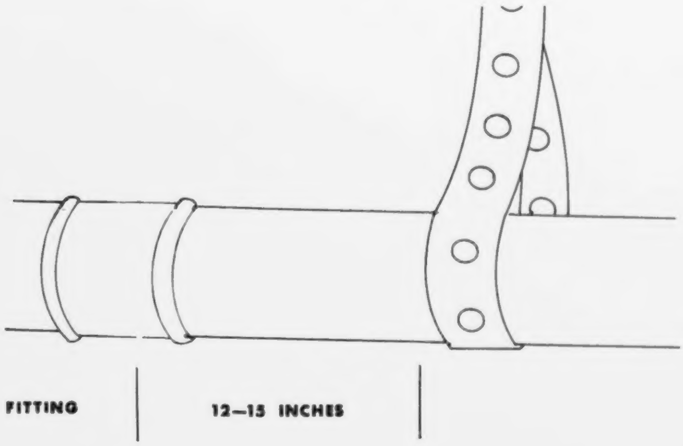

Fig 1-17. Perforated iron strap pipe hanger supporting fitting.

The threaded part of the pipe extending into the fitting is the weakest portion of the pipe run. Although not used in the actual joining of the pipe, pipe hangers are used to support the pipe run, hangers are used to support each fitting where there is stress or weight, for instance in long ceiling runs. Pipe hangers are placed 12-15 inches from each fitting in overhead installations. Figure 1-16 shows a typical overhead pipe hanger. Figure 1-17 shows a perforated iron strap type hanger which is supporting a pipe 12-15 inches from a fitting.

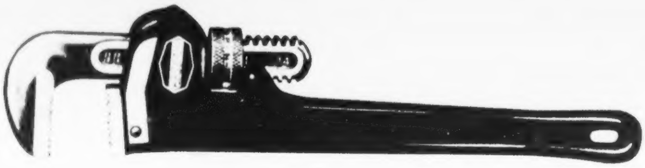

Fig 1-18. Stillson pipe wrench.

In addition to a pipe vise (which was discussed earlier), the Marine plumber will also need to use a Stillson wrench (fig 1-18), hereafter called a pipe wrench.

Wrench Size	Maximum Pipe Capacity
6"	3/4"
8"	1"
10"	1-1/2"
12"	2"
14"	2"
18"	2-1/2"
24"	3"
36"	5"
48"	6"
60"	8"

Fig 1-19. Wrench size.

Adjustable jaw wrenches have serrated teeth which grip firmly when the wrench is turned around a pipe. Pipe wrenches are available in various lengths for different sizes of pipe. Pipe wrenches range from 6 to 60 inches. As a Marine plumber, you will work with sizes 6 through 36 inches. The size of the wrench is usually shown in raised numbers on the wrench handle. The guide in figure 1-19 shows the recommended wrench size for various sizes of pipe. As with all tools, the pipe wrench should not be misused. A pipe wrench should not be used as a leverage bar. A short piece of pipe extended over the handle of a pipe wrench creates added leverage on a stubborn fitting, but this should not be done except when all other means have been exhausted. A larger pipe wrench should be used instead. Striking the handle of a pipe wrench with a hammer to loosen a "frozen" fitting is NOT recommended. When you are joining a run of pipe and a vise is not available, two pipe wrenches can be used, one for holding and one for turning.

Chain tong wrench (fig 1-20) is ideal when working in tight quarters and with large diameter pipe. (When piping runs tight up against a wall or floor, you may not have enough clearance for the jaws of a standard pipe wrench.) Figure 1-21 shows a chain wrench being used where there is a minimum clearance.

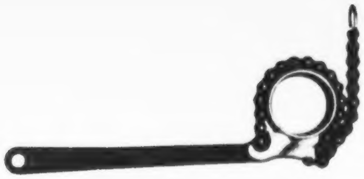

Fig 1-20. Chain tong wrench.

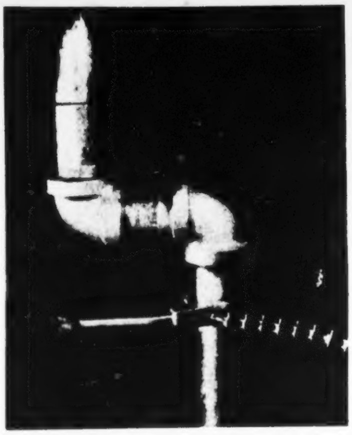

Fig 1-21. Chain wrench used in tight quarters.

Pipe fittings are used to join, reduce, change the direction of, and extend pipe. Fittings are available to fit all pipe sizes. Fittings are made from different materials (iron, copper, plastic) just as are pipes. You should use a fitting and a pipe of the same material, because interchanging (use of a different material fitting/pipe) can cause a reaction which will speed up corrosive action. If interchanging is necessary, then an adapter must be used. Adapters will be discussed below.

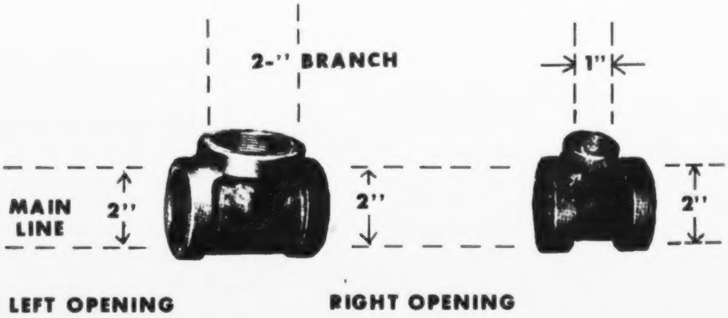

Fig 1-22. Straight tee (2 x 2 x 2 inch) and (2 x 2 x 1 inch) reducer tee.

The size of the fitting is determined by the size of the pipe it is going on. A 1-inch pipe requires a 1-inch fitting or 1 inch I. P. S. (iron pipe size). Male fittings have threads on the outside of the fitting and female fittings have threads on the inside of the fitting. You identify fittings by the name of the fitting and the size of the openings in the fitting. Read from left to right on the main line and then the branch line. To identify the fitting in figure 1-22, we would think to ourselves, "a 2-inch opening on the left side of the main line, a 2-inch opening on the right side of the main line, and a 2-inch opening in the branch line." This would read as a 2 x 2 x 2 inch tee fitting or a 2 x 2 x 2 inch straight tee fitting. It is called a straight tee because the branch opening is the same size. If the branch opening were a smaller size, it would be called a reducer tee.

In your daily plumbing work there will be some types of fittings which you will use more often than others. The following are some of the more common ones:

- Tee: This fitting is used if you need to run a branch line from a main pipe at a 90° angle while still maintaining your original run. It is also used to install gages or faucets on the branch opening. Figure 1-22 shows the most common type tee, a straight tee.

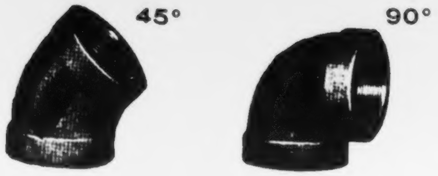

Fig 1-23. Straight elbows (45^{o} and 90^{o}).

- Elbow: Sometimes called an "ell" is used to change the direction of a pipe at the end of the run. Some change the direction 90^{o} and are called 90^{o} ells. Other times you may just want to angle off slightly; then a 45^{o} ell is used. Figure 1-23 shows the common 90^{o} and 45^{o} straight elbows.

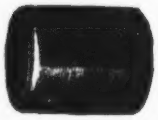

Fig 1-24. Coupling.

- Coupling: This fitting is used to join two pieces of the same size of pipe in a straight run. Figure 1-24 shows a coupling.

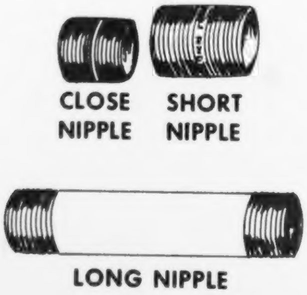

Fig 1-25. Close, short, and long nipples.

- Nipple: A nipple is a short piece of pipe (maximum length 12 inches) with threads on the outside diameter of both ends. There are three types of nipple fittings: close, short, and long. A close nipple has threads running the whole length of the nipple. A short nipple has a greater threaded portion then as unthreaded portion. A long nipple has a smaller threaded portion than unthreaded portion. Figure 1-25 shows the three types of nipples.
- Union: This fitting is used where there may be a future need to undo or disconnect a portion of the run of pipe without dismantling the whole run. By the simple loosening of the collar on this fitting the pipe run is disconnected. Figure 1-26 shows a pipe union. Figure 1-27 shows a cutaway view of a pipe union. A pipe union may also be used to join two runs of pipe at a straight line meeting point.

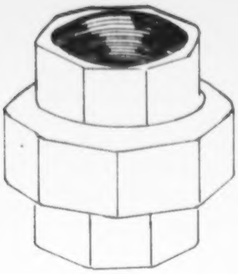

Fig 1-26. Pipe union.

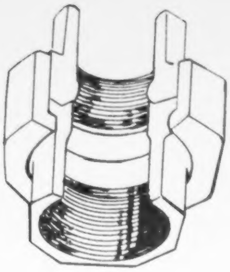

Fig 1-27. Pipe union (cutaway view).

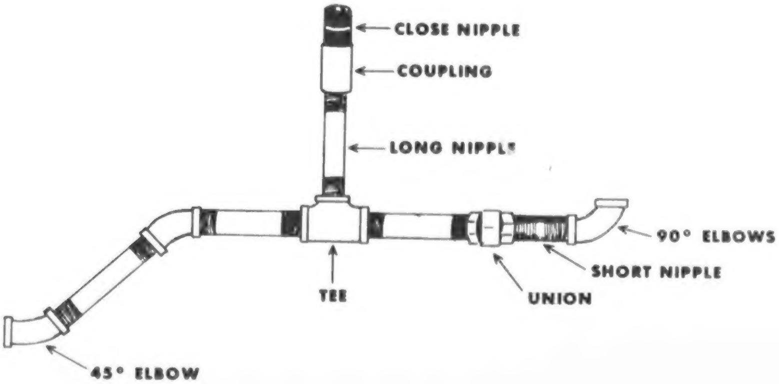

Fig 1-28. Connections with common fittings.

Figure 1-28 shows connections that can be made with common iron pipe fittings that were previously mentioned.

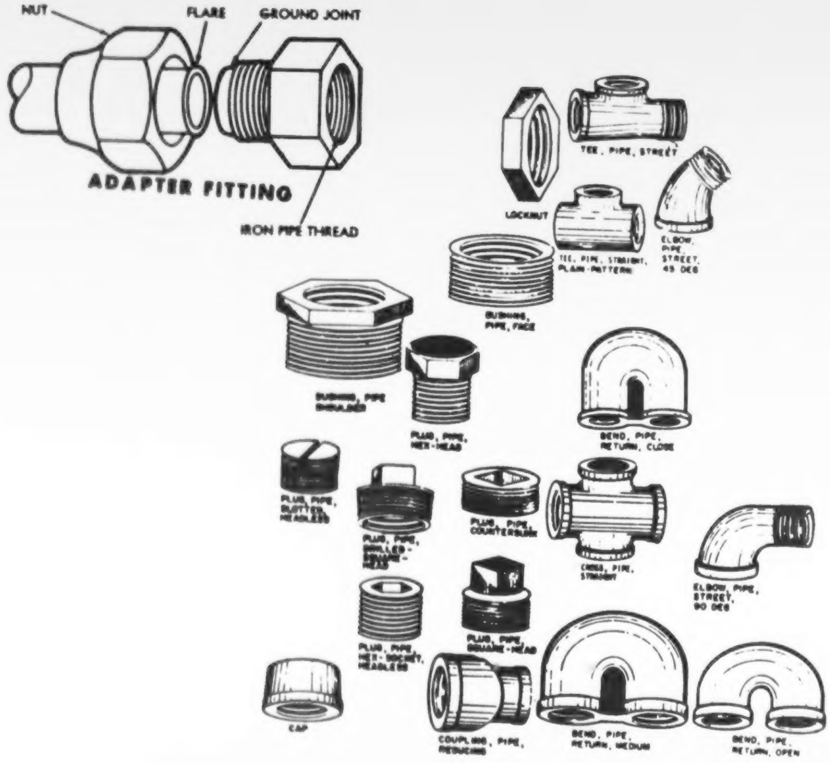

Fig 1-29. Other iron threaded pipe fittings.

In the course of your plumbing job it may be necessary to use other types of fittings. Figure 1-29 shows some other fittings you will encounter. Note the adapter fitting shown in the upper left side of figure 1-29. This is used when you are required to join together pipes which are made of different materials. If you tried to join a fitting made of one material directly to a pipe made of another material, there is a good chance that the two different materials would react chemically to each other and the joint would corrode and eventually weaken. The adapter fitting will bridge the gap between the two materials with a fitting made of a material that will not react to either one.

Valves are used to control (regulate, direct, or stop/shut off) the flow of air, gas, or water. Each type of valve has a different function. Some are used only to shut off a line while others are used to limit or control the flow. Valves that are used with iron pipe are usually made of brass and are available in the same sizes as the pipe.

In this paragraph we will discuss the common types of valves you will be working with as a Marine plumber.

- Gate valve: This type valve is used to stop or start the flow and should be either fully opened or fully closed. Gate valves can be installed without regard to the direction of flow, although some valves must be installed with regard to the direction of flow. Figure 1-30 shows a cutaway view of a typical gate valve. The flow of water is stopped by turning the stem clockwise. This turning action screws the wedge down through the flow until the wedge reaches the seat at the bottom of the valve. The seat is the name given to the place where the wedge meets the bottom of the valve and stops the flow. Figure 1-31 shows the outside view of a gate valve. As you can see from the figures, these valves can be taken apart and repaired, if necessary. If a leak develops in the gate valve, it can usually be stopped by slightly tightening the packing nut (fig 1-30). If this is not sufficient, the valve packing may need to be replaced. The valve packing is a graphite or asbestos based fiber cord. When the packing nut is screwed down (tightened), the packing forms a watertight seal around the stem. It is not recommended that you, as a basic plumber, overhaul these although you certainly can replace the packing. Seek experienced advice before dismantling or adjusting the valve as you may damage it.

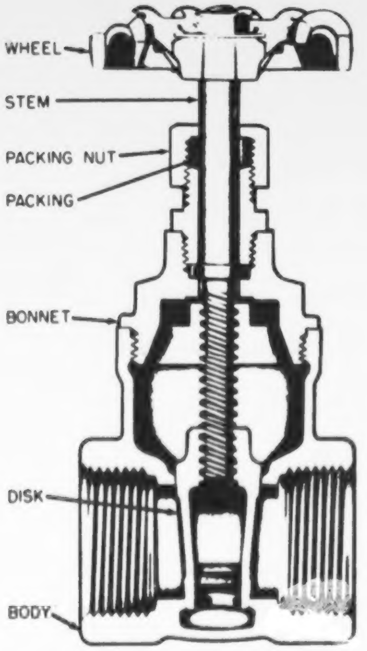

Fig 1-30. Gate valve (cutaway).

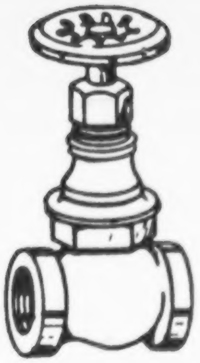

Fig 1-31. Gate valve.

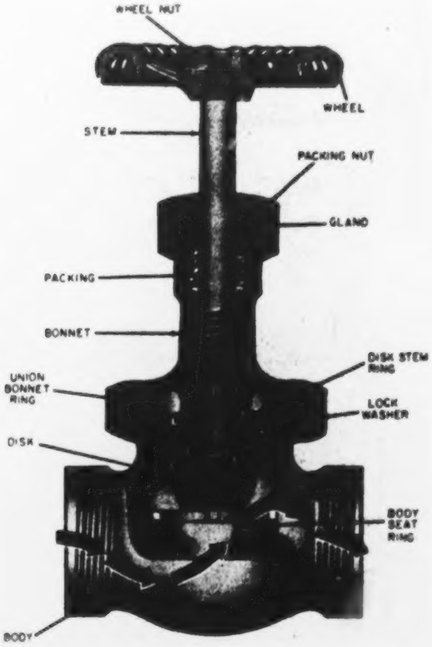

Fig 1-32. Globe valve (cutaway).

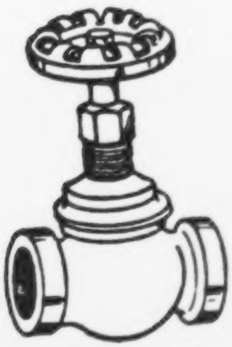

Fig 1-33. Globe valve.

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- Globe valve: Figure 1-32 shows a globe valve's cutaway view, and figure 1-33 shows an outside view. The globe valve is used to regulate the rate of flow in one direction only. The globe valve has an arrow or inlet and outlet marking on its body which shows how the valve should be installed in relation to the direction of flow. This valve differs slightly from the gate valve. As can be seen in figure 1-32, the flow of water is stopped when the disc enters its "seat" in the middle of the valve. the disc is like a plug and will prevent the flow of water. If the situation were as shown in figure 1-32, the water would be prevented from flowing from left to right. The disc may be replaced if it becomes worn. When shutting off a valve, just enough pressure should be exerted to stop the flow because excessive tightening could damage the valve.

- Angle valve: The angle valve is basically a globe valve with the inlet and outlet at 90° to each other. The angle valve controls the flow and changes the direction of a line. Figure 1-34 shows an angle valve.

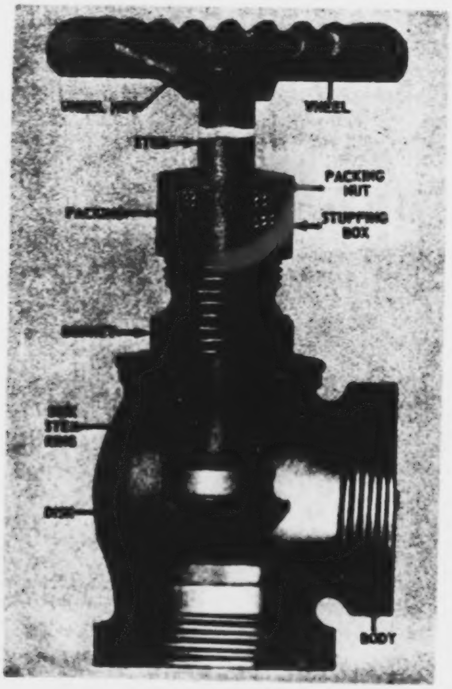

Fig 1-34. Angle valve (cutaway view).

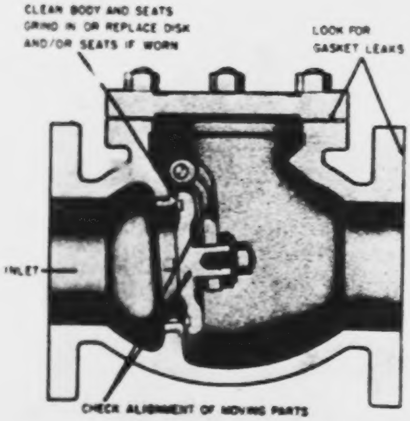

Fig 1-35. Swing check valve.
(cutaway view)

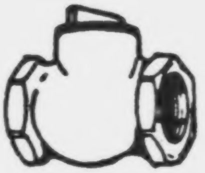

Fig 1-36. Swing check valve.

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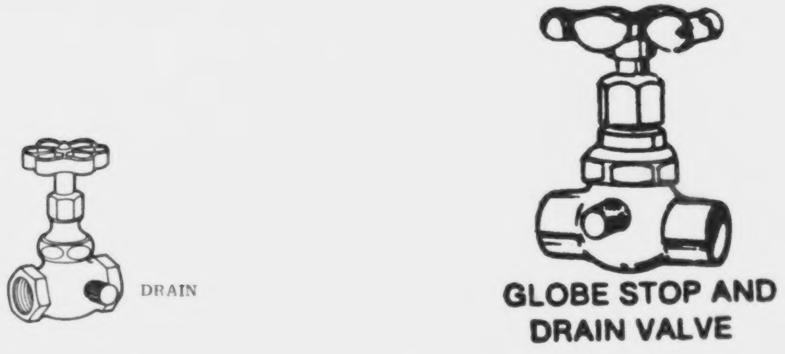
- Check valve: The check valve allows flow in one direction only and it operates by itself. There are different types of check valves (swing check, ball check) but they all function the same way. When the flow is stopped or reversed, this mechanism falls on its seat and shuts off or checks the flow. These valve openings are marked inlet and outlet on the body so the valve must be installed accordingly. Figure 1-35 shows a cutaway view of a check valve showing the swing check mechanism, and figure 1-36 shows an outside view.



Threaded Soldered

Fig 1-37. Stop and waste cock valve.

You may come in contact with other types of valves in your job as a Marine plumber. Some of the other valves include the temperature or pressure relief valve. These valves relieve excess temperature or pressure from a system by using a spring loaded mechanism that will work when the temperature or pressure goes beyond certain preset limits. Another valve is the pressure reducing valve which regulates the pressure in the line. The stop and waste cock is another valve that functions similarly to a globe valve. This valve has a small side drain on the valve body which permits draining of the pipe system when freezing weather threatens in the winter. If this type of valve is not used in cold weather situations, there is a good chance that fluid in pipes will freeze and crack the pipes. Figure 1-37 shows a stop and waste cock valve.

Traps are plumbing fixtures which, as the name implies, are designed to trap or block sewer gases from entering the house or building. Traps do this by providing a liquid seal between the fixture and the source of the gas. This seal prevents air from entering the waste pipe while liquid is flowing as well as eliminating noise. Figure 1-38 shows a trap seal. When water is lost from the trap or when what plumbers call "trap seal" loss happens, it is usually caused by inadequate venting of the trap. (Venting will be discussed later in the text.) The trap seal can also be lost when foreign objects (rags, string, lint) which act as a wick cause the water to be drawn up into the wick-like material until the seal is exhausted. Furthermore, a trap seal can be lost through evaporation when a fixture is not used for a long time (approximately 3 weeks or more).

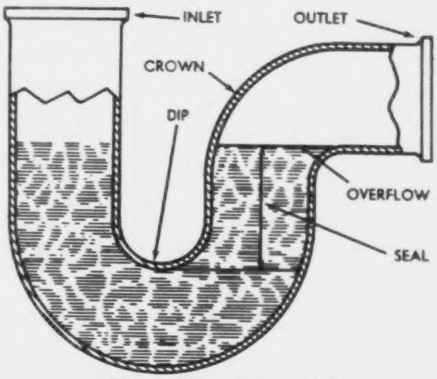


Fig 1-38. Trap seal.

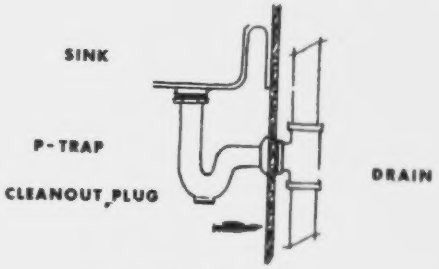


Fig 1-39. P-trap.

The P-trap is used with kitchen and bathroom sinks and lavatories. P-traps are usually made of brass tubing are chrominum plated, and may have a clean out plug at the bottom. Figure 1-39 shows an installed P-trap.

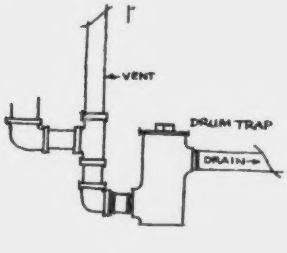


Fig 1-40. Drum trap installation.

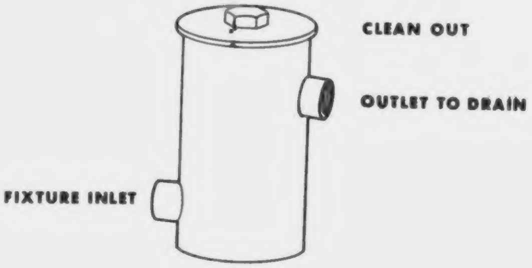


Fig 1-41. Drum trap.

Drum trap, as the name implies, looks like a drum and it functions the same way as other traps. Drum traps are usually found in bathtub and shower installations because they allow for faster passage of water and are not easily clogged. Figure 1-40 shows an installation using a drum trap. Figure 1-41 shows a drum trap.

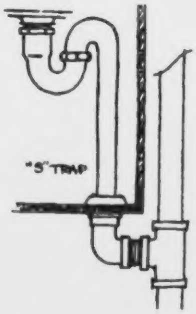


Fig 1-42. S-trap.

S-traps have several characteristics which make them an undersirable trap to use: the seal is shallow; the trap is easily obstructed and is readily siphoned. We discuss the S-trap here because you may run across an installation that still has an S-trap. If you find one, replace it with a P-trap if at all possible. Many local plumbing codes do not allow the use of S-traps. Figure 1-42 shows the installed S-trap.

You have been given a basic introduction to the plumber's field with the emphasis on iron pipe and fittings. Although they are not often used today on new construction, iron pipe and fittings still have several useful applications and will be found in many older installations. You have been provided with some of the terms, tools, and techniques associated with iron pipe. However, you must work on the job with the type of pipe and fittings we've mentioned to become really familiar with them. The information provided in this work unit will give you the basic knowledge that you need before you go out in the field and apply it. Next you will learn about plastic pipe and fittings.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. At the present time iron and steel pipe is NOT often used because it is

2. Since iron pipe is expensive, the Marine Corps does not use it in

3. In which length does the Marine Corps order iron and steel pipe?

4. The only choices available when ordering iron pipe are threaded or ______________.

5. The smallest inside diameter iron and steel pipe available is __________ inch.

6. What is the main purpose of the cold water distribution system?

7. Which part of the plumbing system supplies portable water to a building from a water main?

8. Which part of the plumbing system heats water and distributes it to the various fixtures?

9. By which means is the weight of iron and steel pipe determined?

10. Which weight of iron and steel pipe is most frequently used by the Marine Corps?

11. Which of the following would be more apt to use double extra strong iron and steel pipe?

12. Prior to cutting pipe, you should first measure it by using a folding rule or a

13. When cutting iron and steel pipe, one of the tools used to hold the pipe securely is a ______________________________

14. Which should be used to cut pipe so that it is even and square?

15. Reaming restores the pipe to its original ______________________

16. What is the name of the tool used to remove burrs from iron and steel pipe?

17. Which are the main components of the pipe threader?

18. A good grade of lard oil may be used in the threading process to lubricate the die or a good grade of cutting oil containing ______________________

19. When threading pipe, how should cutting and threading oil be used?

20. Center to center, end to end, end to center, face to center, and face to face are types of measurement used for the proper ______________________

21. Why should the Marine plumber use pipe dope when joining pipe?

____

22. The two types of pipe dope which are available to the Marine plumber are compound and ____

23. The tools used for joining iron and steel pipe are pipe wrench, vise, and

____

24. When joining pipe in a tight, confined area, which of the following tools would help you in your work?

____

25. The straight coupling is a common type of fitting used to join two pieces of pipe ____

26. Which is a characteristic of a nipple type of fitting?

____

27. A union is a fitting used where there might be a need to ____________________

28. Which fitting should you use when joining pipes of different materials?

____

29. The five most common types of iron and steel threaded fittings are the tee, coupling, nipple, union, and ________________________________

30. The gate, globe, angle, and check valves each have their own special function in a plumbing system. Some of these functions are shutting off the flow of water, directing the flow, and ________________________________

31. The check valve is used in a piping run where it is desirable to have ____

32. The globe valve, one of the common valves used with iron and steel pipe, is used where you want to ________________________________

33. Which of the following is a correct statement?

    a. A gate valve regulates the flow of water.
    b. A gate valve permits a flow of water and is either open or closed.
    c. A gate valve must be placed in the proper direction of the flow of water.
    D. A gate valve must never be placed in the proper direction of the flow of water.

34. Why is a stop and waste cock valve used where there is a possibility of freezing weather?

____

35. The S-trap, P-trap, and drum traps stop sewer gases from entering into a building by ____

36. The use of the undersirable S-trap is prohibited by most ____________________

Work Unit 1-2. PLASTIC PIPE AND FITTING

IDENTIFY THE FORMS IN WHICH PLASTIC PIPE IS AVAILABLE.

IDENTIFY THE ADVANTAGES AND DISADVANTAGES OF PLASTIC PIPE.

IDENTIFY THE METHODS OF CUTTING AND JOINING PLASTIC PIPE.

IDENTIFY THE AVAILABILITY OF PLASTIC PIPE, VALVES, AND FITTINGS.

IDENTIFY THE VARIOUS USES OF PLASTIC PIPE, VALVES, AND FITTINGS.

Just a few years ago plastic pipe installations in a building would have been unusual, but this is the age of plastics, and they are probably the dominant material used in the plumbing industry today. As a Marine plumber, you will come in contact with many types of plastic plumbing installations. It is important for you to be able to identify the different types of plastic pipe and fittings and to know how each is utilized.

Plastic pipe and fittings have many advantages over those made of other materials. Plastic pipe and fittings are used in cold and hot water supply systems, drainage and sewage systems, water service lines, and industrial and chemical plants.

This work unit will be concerned with the types of plastic pipe and fittings used in the military and the advantages and disadvantages of each. How plastic pipe is cut and joined and how it is used in hot and cold water systems and drainage and sewage systems will also be covered.

Plastic pipes and fittings are manufactured in two different forms: rigid and flexible. You will use both forms during your career as a Marine plumber.

Rigid plastic pipe, which is manufactured with a hard wall, can be cut, threaded, and joined, but it cannot be bent. This work unit will be concerned with the three common types of rigid plastic pipe: polyvinylchloride (PVC), chlorinated polyvinylchloride (CPVC), and acrylonitrile butadiene styrene (ABS).

- PVC is used for cold water applications and drain, waste, and vent (DWV) applications. This pipe is available in sizes from 1/8 inch to 12 inch I.D. and in lengths of 20 feet. Normally in a DWV application you should use PVC ranging from 1/2 inch to 5 inch I. D.

- CPVC pipes and fittings are used for hot water applications of up to 215° F (102°C). CPVC is available in sizes from 1/4 inch I. D. to 3 1/2 inch I. D. and in lengths of 10 feet and 20 feet.

- ABS is used only in drain, wastes, and vent applications. It is available in sizes from 1/4 inch I. D. to 12 inch I. D. and in lengths of 10 feet and 20 feet. ABS requires a special cement and special fittings.

Fig 1-43. The light weight of flexible plastic pipe.

Flexible Polyethylene (PE) (fig 1-43) is a form of plastic pipe used for cold water applications. It has a flexible wall similar to a plastic garden hose. PE can be cut with a knife or hacksaw. It is available in sizes from 1/8 inch I. D. on up and comes in coils of 3500 feet.

Like most things, plastic pipe has its advantages and disadvantages. The advantages far outweigh the disadvantages, and for that reason, plastic pipe is currently dominating all other materials in plumbing installations. Some of the advantages are low initial cost, rapid installation, light weight (ease in handling (fig 1-43)), corrosion resistance, and joining methods. Another advantage is that it does not add odor or taste to the water. Some of the disadvantages are that plastic pipe should not be used for either high temperature or high pressure applications. The pipe also has a low resistance to impact which makes it an undesirable type of pipe to install where there is a chance of it being damaged.

The light weight of flexible pipe is shown in figure 1-43. A 100-foot coiled length of 3/4-pipe weighs only 3 3/4 pounds (1.7 kilograms), a small fraction of the weight of a comparable length of steel pipe.

Certain characteristics of plastic materials make working with them dissimilar to other materials. An example of this dissimilarity is the procedure for cutting plastic pipe.

Even though the precise measurements described in the preceding work unit dealing with iron pipe are not required for working with plastic pipe, they are still important for good quality work. So for all practical purposes, the measuring tools and procedures involved with iron pipe can be applied to plastic pipe.

Plastic pipe can be cut with a hacksaw, a carpenter's handsaw, or a pocket-knife.

- Hacksaw: The tool has been used with success in cutting small diameter rigid and flexible plastic pipe. The hacksaw provides a cut with minimum burrs because of the small teeth on the blade. Figure 1-44 shows an adjustable type of hacksaw.

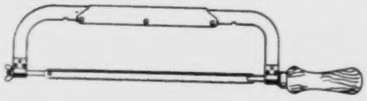


Fig 1-44. Adjustable hacksaw.

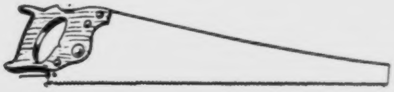


Fig 1-45. Carpenter's handsaw.

- Carpenter's handsaw: The crosscut handsaw has proven to be a good plastic cutting tool. Figure 1-45 shows a carpenter's handsaw. The carpenter's crosscut handsaw is most suitable for use on larger diameter rigid plastic pipe.
- Pocketknife: An ordinary pocketknife can be used to cut flexible plastic pipe. Care should be used to insure that a clean flat cut is made. The knife should be sharp and large enough to provide easy cutting. A pocketknife is recommended for use with smaller sizes of flexible pipe only.

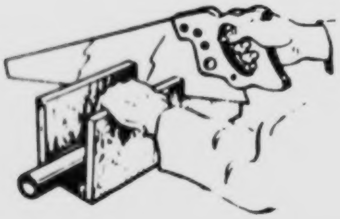


Fig 1-46. Miter box cutting guide.

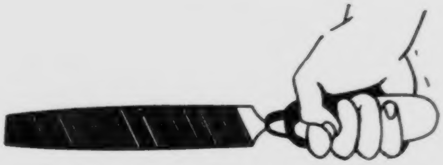


Fig 1-47. Hand file.

The plastic pipe to be cut should first be carefully measured. The next step is selecting your cutting tool. Your choice should depend on the type and diameter of pipe to be cut. The plastic pipe to be cut should be well supported. The cut should be flat and square. The use of a miter box or similar cutting guide is recommended when using a saw. Figure 1-46 shows a miter box and a carpenter's handsaw being used to cut plastic pipe.

After cutting the pipe, the cut ends can be bevelled with a hand file (fig 1-47). If there are burrs on the inside, they can be taken off with a pocketknife. It is important to remove all dust and chips from the inside of the pipe before joining it since any foreign material left inside the pipe may cause problems. Examples of such problems include the possible plugging of a valve, addition of a bad taste to water in a pipe, or a heat buildup by friction from burrs or chips.

Joining is the critical portion of plastic pipe installation. You may have done everything correctly so far in selecting and cutting the pipe; however, if you do not join the pipe properly, the work you have done will be wasted. Rigid pipe is joined in a different way than flexible pipe and requires a little more know-how. Rigid plastic pipe should be joined by one of these methods: adhesive, hot gas weld, or threaded fitting. Of these three, the adhesive method is used most often by the Marine plumber. Flexible plastic pipe should be joined by couplings and clamps.

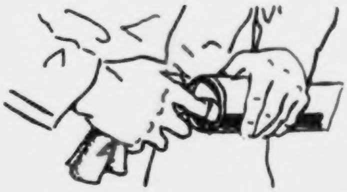


Fig 1-48. Wiping joint surfaces with a rag.

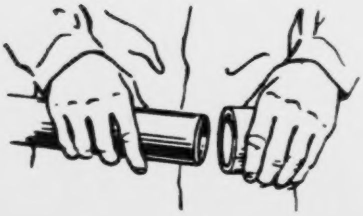


Fig 1-49. Checking dry fit.

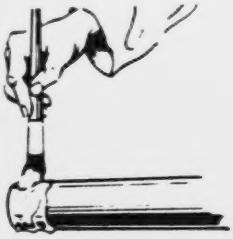


Fig 1-50. Applying solvent cement.

There are two types of adhesive which are used to join rigid plastic pipe. One type works just like glue to hold the two surfaces together. The other type has a solvent base cement which actually dissolves the plastic surfaces to be joined a fraction of an inch, thus allowing the two plastic surfaces to form a strong chemical bond with each other. This is sometimes called a solvent weld. You should use the correct type of cement or solvent cement for the particular type of pipe being joined. If you are working with PVC pipe, you should use a PVC cement. If you are working with CPVC, you should use a CPVC cement. Pipe size and class also determine cement usage. The wrong type of cement can cause failures (leaks) in the joints. The best way to insure correct usage is to check with the pipe manfacturer's specifications. Now you have reached the point where you are about to make the actual joint. Wipe the joint surfaces with a clean rag to insure that you have a clean, dry bonding surface (fig 1-48). "Dry fit" the joint (put it together without cement) one time to insure that it fits properly (fig 1-49). A good dry fit will enable the pipe to be inserted into the fitting socket from about 1/3 to 3/4 of the distance to the end of the fitting socket. The fitting socket is that part of the inside of the fitting that is especially made to hold or accept the pipe when joining. If the "dry fit" is too tight, the pipe can be sanded down for a better fit. If the pipe is too loose, extra applications of cement will usually help get a better fit. Now, using a clean solvent cement applicator brush, apply cement liberally on the male end of the pipe (fig 1-50).

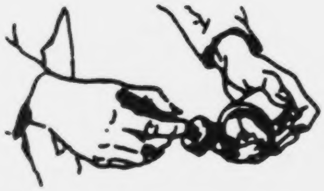


Fig 1-51. Applying cement to fitting socket.

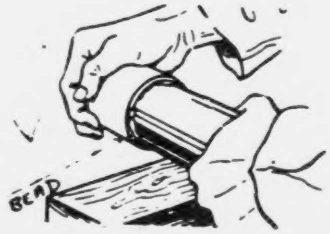


Fig 1-52. Inserting pipe into a fitting.

The amount of solvent cement applied should be more than enough to fill any gaps. Next apply a light coat of solvent cement to the inside of the fitting socket using outward strokes to keep excess cement out of the inside of the pipe (fig 1-51). Now, while both surfaces are still wet with solvent cement, insert the pipe into the fitting socket with a 1/4 turn twisting motion in either direction (fig 1-52). The pipe must go to the bottom of the fitting socket. This whole process of applying the cement and inserting the pipe into the fitting should be completed in less than 1 minute. The bead of cement (fig 1-52) that accumulates on the edge of fitting and pipe should be wiped off (before it dries) to complete the joining process. In temperatures of 60° F to 100° F (15.5° C to 37.8° C), the joint should be allowed to set for approximately 30 minutes before being disturbed. In colder climates a longer period is needed. A rule of thumb is that for each decrease of 20° under 60° F, you should let the joint set an additional 30 minutes.

As a basic Marine plumber, you will probably never use the hot gas weld method of joining rigid plastic pipe. The hot gas weld (heat weld) is mentioned here only so you will know that such a method exists and that it should be used by highly trained personnel. Hot gas welding of plastic pipe employs commercially available hot gas or air welding equipment. A welding temperature between 500° F and 600° F is needed. The welding rods are made of polyvinylchloride (PVC).

Rigid plastic pipe can be threaded using some of the tools and techniques that were previously mentioned for iron pipe. Extreme care should be taken to insure that the plastic pipe is not damaged. Extra sharp dies should be used to obtain good threads. It is recommended that the basic Marine plumber should attempt to obtain prethreaded pipe and fittings if there is a need for them. A tight joint can be made by using the threaded joint assembly and pipe dope is not normally needed. However, a standard pipe dope/compound is recommended to provide lubrication and help seal the joint. The pipe dope/compound should also make it easier to disassemble the joint if there is a need to do so later on. Threaded fittings should be started carefully and hand tightened. Further tightening should not be necessary to make a leakproof joint. However, if necessary, further tightening should be done by using a strap wrench but only to a point 1/2 to 1 1/2 turns past hand tight. Figure 1-53 shows two types of strap wrenches.

Note: Under no circumstances should a stillson/pipe wrench be used on plastic pipe because the ridged jaws of this type of wrench could damage the pipe.

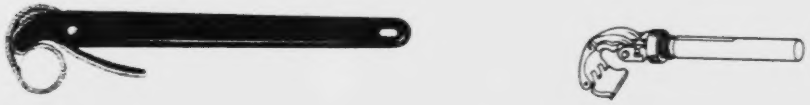


Fig 1-53. Strap wrenches.

Flexible plastic pipe is joined by using plastic couplings and clamps. The couplings have serrated (ridged) ends (fig 1-54) which fit snugly into the ends of the two pieces of plastic pipe being joined. When the coupling is in place, two stainless steel clamps are screwed down tightly around the outside of the plastic pipe. Figure 1-54 shows the items required to join flexible pipe in this manner.

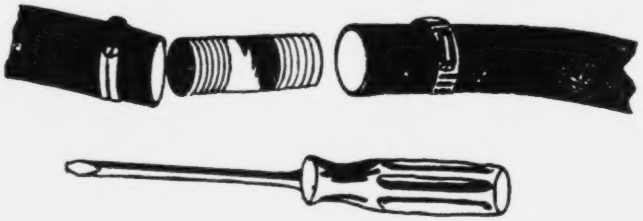


Fig 1-54. Items required to join flexible plastic pipe.

There are also plastic adapters that can be used to join flexible pipe to iron or steel pipe. An adapter that is used to connect flexible pipe to a steel elbow is shown in figure 1-55. One end is serrated (for plastic pipe) and the other end is threaded (for steel pipe).

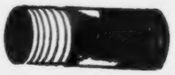


Fig 1-55. Threaded adapter.

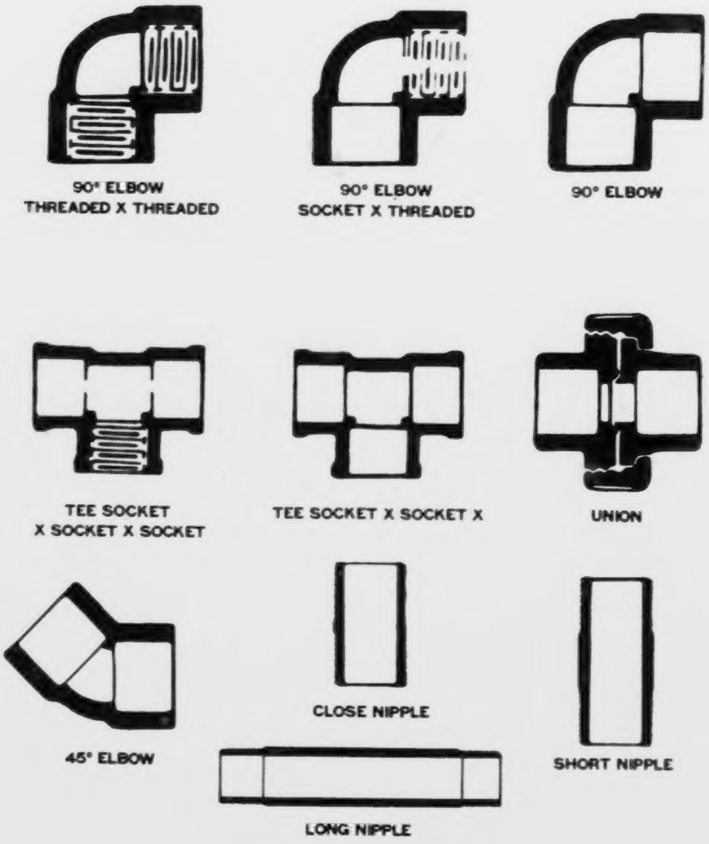
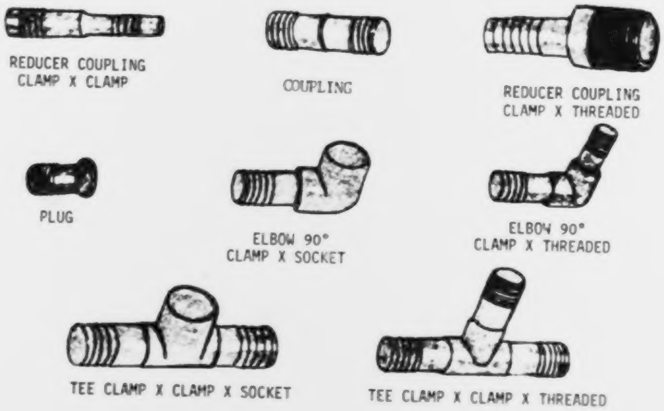


Fig 1-56. Rigid plastic fittings.

There is a full line of plastic valves and fittings available for use with plastic pipe. Until recently plastic was used for cold water applications only but, with the advances made in the plastic industry, you now can use CPVC plastic pipe and fittings in hot water applications as well. Plastic valves are available and are used in many installations. The standard brass valves discussed in work unit 1 can also be used with adapters, and it is recommended that brass valves be used where there is a possibility of heavy usage. The fittings used with rigid plastic pipe are similar in shape to iron and steel fittings. They can be ordered either threaded or nonthreaded (with a socket). Rigid pipe fittings are identified in the same manner as iron and steel fittings. Some of the common types of rigid plastic fittings are shown in figure 1-56.

Flexible plastic pipe fittings are shaped similarly to other fittings except for the serrations on the coupling end of the fitting. These fittings also come in all shapes and sizes. Figure 1-57 shows some of the flexible pipe (PE) fittings available.


REDUCER COUPLING CLAMP X CLAMP

COUPLING

REDUCER COUPLING CLAMP X THREADED

PLUG

ELBOW 90° CLAMP X SOCKET

ELBOW 90° CLAMP X THREADED

TEE CLAMP X CLAMP X SOCKET

TEE CLAMP X CLAMP X THREADED

Fig 1-57. Flexible plastic fittings.

Many state plumbing codes now allow plastic drain and sewage piping to be installed in homes. Plastic sewage lines will not rot when buried. The big drawback with plastic drain and sewage lines in their low resistance to impact. When there is a possibility of damage occurring from impact or vehicles running over a line, plastic pipe should not be used. DWV fittings are available for all types of installations in sizes ranging from 1 1/4 inches to 6 inches in diameter. The DWV fittings are available in three types: threaded, with a spigot (male end), or with a hub. Figure 1-58 shows a sanitary tee fitting with two hubs and one female pipe thread.

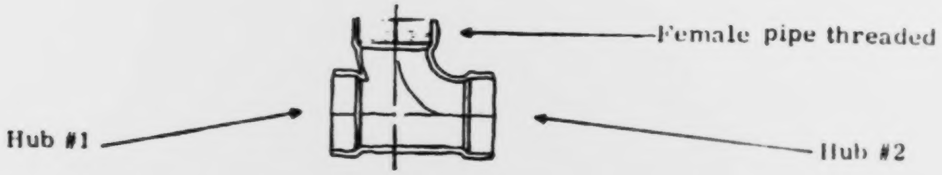


Fig 1-58. A sanitary tee.

In identifying the sanitary tee fitting in figure 1-58, you would read the #1 hub first, the #2 hub second, and the female pipe threaded (FPT) last. Some of the fittings for DWV have the same turning radius as iron and steel fittings, but they are identified differently. A 1/4 bend DWV fitting would actually be equivalent to a 90° elbow. A 1/8 bend DWV fitting would be equal to a 45° elbow. There are also DWV fittings available in 1/6 bends (60°) and 1/16 bends 22 1/2°). If a fitting has one spigot end (male) and one hub end, it would be called a "street" fitting. Figure 1-59 shows a 1/16 bend, street fitting.

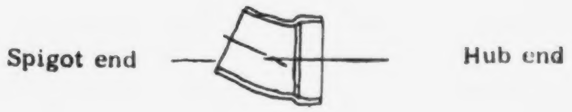


Fig 1-59. Street fitting, 1/16 bend.

Figure 1-60 shows you how reducing fittings are read and ordered.

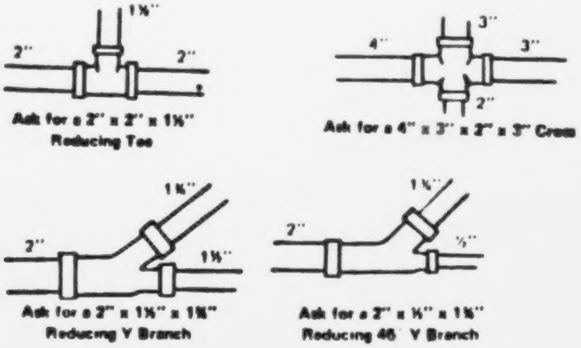


Fig 1-60. Reducing fittings (how to read and order).

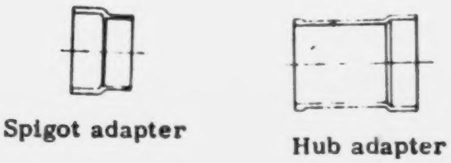


Fig 1-61. Adapters.

When there is a need to connect plastic DWV to other materials such as cast iron, there is a full line of adapters available. Figure 1-61 shows the adapters that are used to join plastic to cast iron. The spigot adapter joins a cast iron spigot to a plastic DWV spigot. The hub adapter joins a plastic DWV spigot to a cast iron hub.

Fig 1-62 shows some of the plastic DWV fittings you may come in contact with.

There is a full line of traps available for plastic DWV. The features of plastic DWV traps are the same as those discussed in work unit 1-1. The plastic DWV traps come in sizes ranging from 1 1/2 inches to 4 inches in diameter. Figure 1-63 shows some plastic DWV traps.

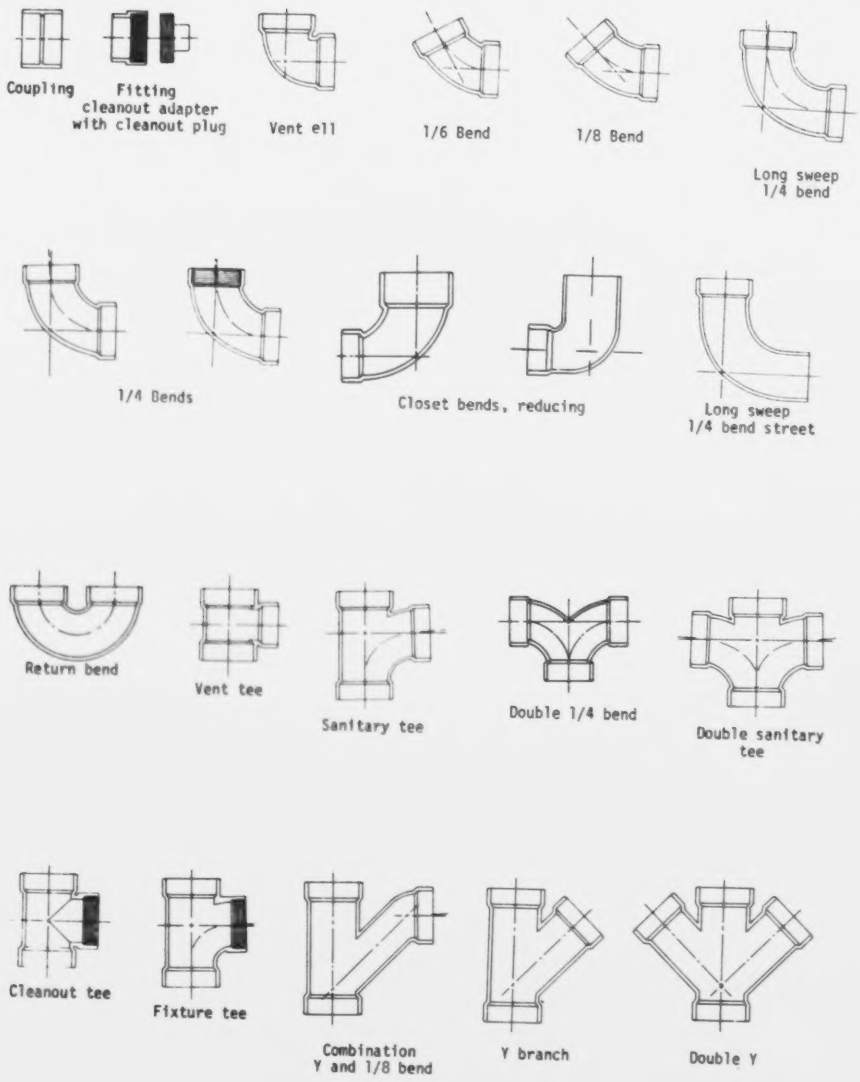


Fig 1-62. DWV fittings.

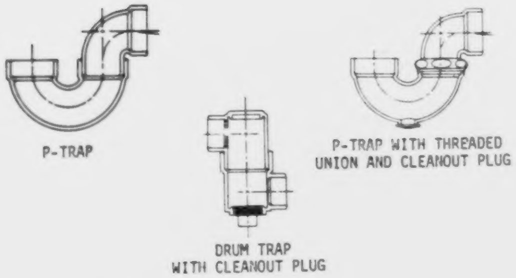

P-TRAP
DRUM TRAP WITH CLEANOUT PLUG
P-TRAP WITH THREADED UNION AND CLEANOUT PLUG

Fig 1-63. Plastic DWV traps.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

Matching: In the group of items below (items 1-3) match the abbreviation in column 1 with the statement to which it applies in column 2. Place your answer in the spaces provided.

Column 1 Abbreviation	Column 2 Definition
1. ____ABS	a. Flexible form of plastic pipe
	b. For cold water installations only
2. ____CPVC	c. Used for DWV only
	d. Used on hot water applications
3. ____PE	

4. Plastic pipe is available in rigid and ______________ types.

5. PVC is a form of plastic pipe that is available in lengths of ___________________.

6. What is a disadvantage in using plastic pipe for a plumbing application?

____

7. An advantage of using plastic pipe is its ______________________________________

8. When cutting plastic pipe with a carpenter's handsaw, it is recommended that you use a cutting guide such as a ____

9. What type of plastic pipe can be cut with a hacksaw?

____

10. What type of plastic pipe can be cut with a pocketknife?

____

11. What type of fit should be attempted before applying the solvent cement?

____

12. When joining two pieces of pipe together, a liberal amount of solvent cement should be applied to the ____

Matching: In the group of items below (items 13-16), match the method of joining plastic pipe in column 1 with the correct tool or equipment needed for the job in column 2. Place your answers in the spaces provided.

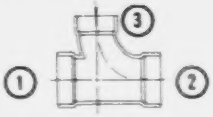
Column 1 Method	Column 2 Correct tool or equipment
13. _____Adhesive	a. Screwdriver
	b. Strap wrench
14. _____Hot gas weld	c. PVC solvent
	d. PVC rods
15. _____Threaded fitting	e. Stillson wrench
16. _____Coupling w/clamp	

17. Plastic pipe fittings are available in threaded and _______________ types.

18. The male end of a DWV fittings is called the ___________________________________

19. This plastic DWV fitting would be read or identified by reading the circled numbers in the sequence of

a. 2, 1, 3 .
b. 3, 2, 1 .
c. 1, 2, 3 .
d. 3, 1, 2 .



20. A 1/4 bend plastic DWV fitting would actually be equal to a _______________ elbow.

21. Plastic pipe valves and fittings are used in hot and cold water systems, as well as in ____

22. Fittings which have serrated ends are used in joining ___________________________

23. When there is a possibility of heavy usage, it is recommended that valves used in hot and cold water applications by made of _____________________________________

Work Unit 1-3. CAST IRON SOIL PIPE AND FITTINGS

IDENTIFY HOW CAST IRON SOIL PIPE AND FITTINGS ARE USED.

IDENTIFY THE SIZES IN WHICH CAST IRON SOIL PIPE AND FITTING ARE AVAILABLE.

IDENTIFY THE TOOLS AND THE PROCEDURES USED TO CUT CAST IRON SOIL PIPE.

MATCH THE METHODS OF JOINING CAST IRON PIPE.

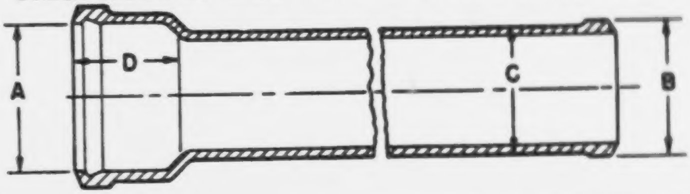
IDENTIFY THE MOST COMMON TYPES OF CAST IRON PIPE FITTINGS.

For many years cast iron soil pipe was the principal piping used in waste systems. Today copper and plastic pipes are used as well as cast iron soil pipe in waste systems. The waste system is that part of a plumbing installation (stacks, vents, and drains) which carries the waste (liquid and solid) to an area where it is treated and/or disposed of. Cast iron soil pipe is the most durable of the piping materials used for waste systems. Although this piping is durable when properly installed, it is brittle and not resistant to impact. For this reason, care must be used when installing cast iron pipe. Once installed properly, this piping will last the life of the building. Even today many plumbing codes specify cast iron soil pipe and fittings for certain applications. Cast iron soil pipe is self-supporting and can be buried underground and in concrete.

As was mentioned in the preceding paragraph, cast iron soil pipe is used on the stack, vent, and drain lines of waste system. Cast iron soil pipe is being replaced by plastic pipe in new installations where plumbing codes allow. Cast iron soil pipe is heavier, more expensive, and requires more time and equipment to install than does plastic pipe. Industrial buildings and some commercial buildings are required to use cast iron pipe and fittings. When waste systems are exposed to heavy loads, such as underground lines which may be run over by heavy vehicles, cast iron soil pipe and fittings are usually specified.

Cast iron soil pipe is available in two weights, standard or service and extra heavy. Figure 1-64 shows the difference in thicknesses between the standard type cast iron soil pipe that is used in most Marine bases and the extra heavy pipe that is used in critical and heavy industrial or commercial buildings. You will be concerned mainly with the standard weight pipe. This type of pipe usually comes in 5-foot lengths and inside diameter sizes of 2, 3, and 4 inches. Cast iron soil pipe can be ordered in sizes form 1 1/4 inch I. D. and up. The most popular form of this pipe is shown in figure 1-65. This figure shows a 5-foot length of single hub pipe with a bell or hub on one end and a spigot or plain end on the other.

DIMENSIONS OF CAST IRON SOIL PIPE IN INCHES



STANDARD				
SIZE	A	B	C	D
2	2 15/16	2 5/8	2 1/4	2 1/2
3	3 15/16	3 5/8	3 1/4	2 3/4
4	4 15/16	4 5/8	4 1/4	3

EXTRA HEAVY				
SIZE	A	B	C	D
2	3 1/16	2 3/4	2 3/8	2 1/2
3	4 1/16	3 7/8	3 1/2	2 3/4
4	5 1/16	4 7/8	4 1/2	3

Fig 1-64. Comparison of standard and extra heavy cast iron soil pipe.

The hub or bell is that end of the pipe into which the spigot end of another pipe is placed for joining. The cutting and joining procedures will be discussed later in this chapter. Double hub lengths of cast iron pipe should be used when small pieces of pipe must be cut for joining. If a single hub pipe is cut, any pipe left over is wasted, but with a double hub pipe there is one hub left for joining. Figure 1-66 shows a length of double thumb cast iron soil pipe.

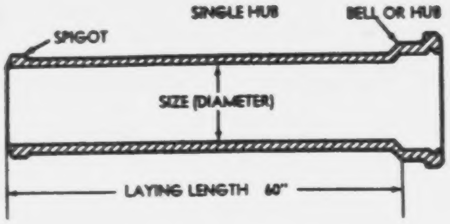


Fig 1-65. Single hub cast iron soil pipe.

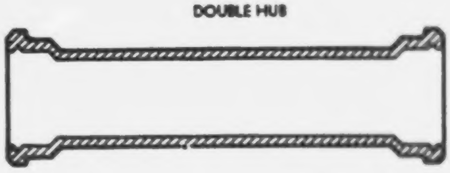


Fig 1-66. Double hub cast iron soil pipe.

Fittings are prefabricated plumbing parts used to connect pipes, make bends, or attach fixtures to pipes in a run. Cast iron fittings are available in standard and extra heavy weights and can be found in sizes of 1 1/4 inches in diameter and up. Cast iron fittings also have a hub or bell for accepting the spigot end of a piece of pipe. Some of the common fittings are branches, bends, and tees. When a plumber talks about cast iron pipe, he refers to an elbow fitting as a bend because cast iron soil pipe has a gradual curve instead of the usual sharp angle. When talking about this type of pipe, a 90 degree elbow would be called a "1/4 bend," and a 45 degree elbow would be called a "1/8 bend." Figure 1-67 shows some of the common cast iron soil pipe fittings. Figure 1-68 shows some of the cast iron fittings that are available. Cast iron fittings are not interchangeable with other kinds of pipe (steel, copper, etc.). A special adapter must be used when you need to change to a type of pipe other than cast iron.

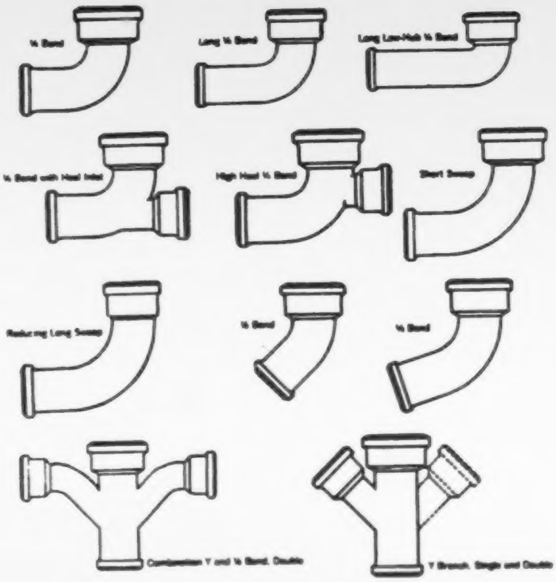


Fig 1-67. Cast iron soil pipe fittings.

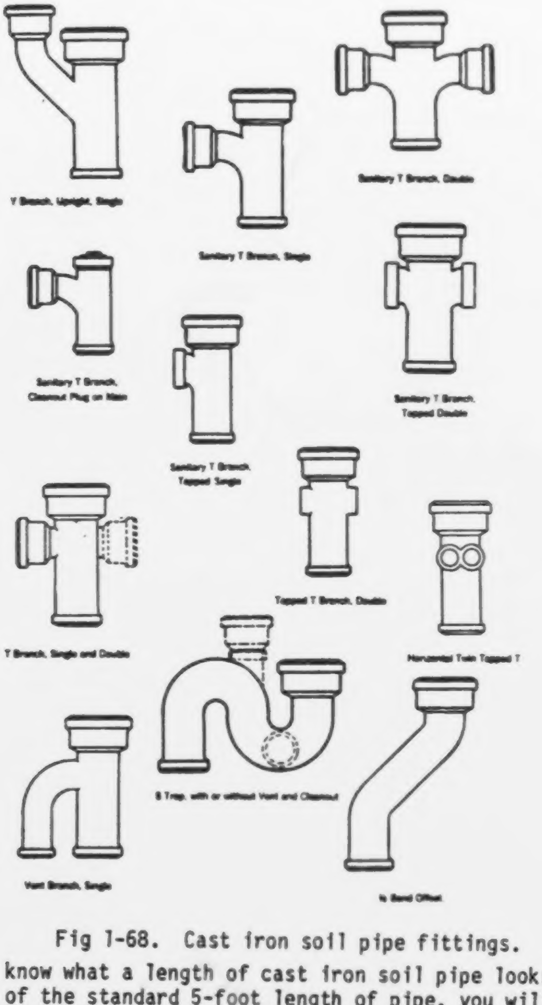

Y Branch, Upright, Single
Sanitary T Branch, Single
Sanitary T Branch, Double
Sanitary T Branch, Cleanout Plug on Main
Sanitary T Branch, Tapped Single
Sanitary T Branch, Tapped Double
T Branch, Single and Double
Tapped T Branch, Double
Horizontal Twin Tapped T
S Trap, with or without Vent and Cleanout
Vent Branch, Single
⅛ Bend Offset

Fig 1-68. Cast iron soil pipe fittings.

You now should know what a length of cast iron soil pipe looks like. If you need a 3-foot section instead of the standard 5-foot length of pipe, you will have to cut it to size. You should use a steel tape measure to determine the length required. Depending on the length of the cut on the pipe and the size of the pipe, you can use a hammer and cold chisel, cast iron soil pipe cutter, or hacksaw to cut the pipe.

Cast iron soil pipe is measured form the back of the hub to the spigot end of the length desired. A steel measuring tape is normally used as the measuring tool. Figure 1-69 shows a length of single hub pipe measured for a 3-foot cut. The measurement is made from the back of the hub to insure that you obtain an accurate overall run length. The spigot end of an adjoining piece of pipe will fit into the front part of the hub. In this paragraph, hub pipe (fig 1-69) is used for instructional purposes only. In actual practice, however, you would normally cut a double hub pipe so that the cut end would not be wasted.

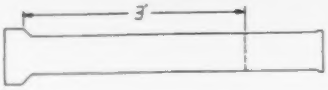


Fig 1-69. Measuring cast iron soil pipe.

After you have measured and cut a thin line completely around the pipe with any type of marker (chalk is good), you are ready to begin your cut. One method of cutting cast iron soil pipe is by using a hammer and cold chisel. To use these tools, place the marked portion of the pipe over a board or mound of earth (fig 1-70). With the cold chisel and hammer, start cutting on the line, using light blows with the hammer. These light blows will create small cuts or scores in the pipe. Rotate the pipe as you cut. When you have the pipe scored completely around, continue the process by gradually increasing the striking force of the hammer on the chisel until the pipe breaks. The secret of getting good clean cuts with the hammer and cold chisel is not to become impatient and try to cut too deeply into the pipe at first. Make sure that the marked line on the pipe is over a board or mound of earth at all times and in such a way as to prevent the pipe from shifting as your hammer strikes the chisel. Improper positioning of the pipe can cause the pipe to crack or break. Remember that this type of pipe is very expensive.

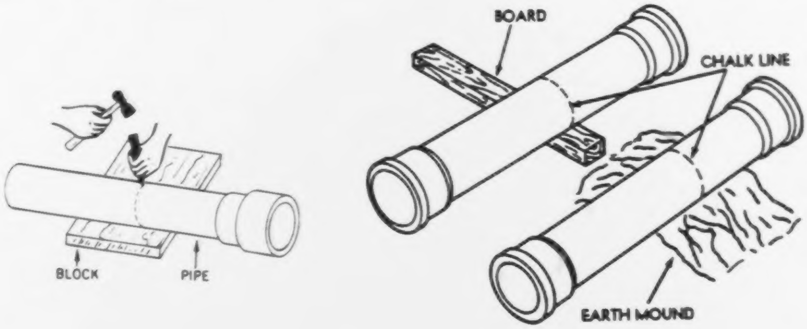


Fig 1-70. Supporting soil pipe for cutting.

A cast iron soil pipe cutter is a tool that will help you work faster and more efficiently. Although the hammer and cold chisel method is a good method for cutting pipe, the cast iron soil pipe cutter enables you to make cleaner cuts more quickly. The tool is placed on the soil pipe in a manner similar to a chain tong (fig 1-71). Place the cutting wheel on the mark you have drawn on the pipe. Adjust the tool so that the cutting wheel is snug on the pipe. If the chain is too tight, the cutting wheels will not turn. Roll the wheels back and forth using the handle provided. Readjust the chain as needed and continue rolling the chain back and forth until a clean cut is made.

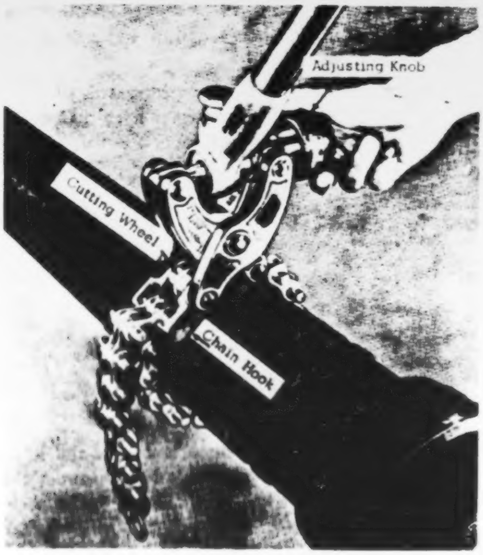


Fig 1-71. Cast iron soil pipe cutter.

Sometimes you may find it necessary to cut only a few inches off a length of cast iron pipe. If you use the cold chisel and hammer method in this situation, there is a chance that you may crack the pipe. In addition, you may not have enough room on the pipe to use a pipe cutter. In this case you would use an ordinary hacksaw (fig 1-72).

Note: Insure that the hacksaw blade teeth are pointing away from the handle. This is the proper way to use a hacksaw.

Fig 1-72. Hacksaw.

Using slow, even strokes on the hacksaw (to prevent overheating the blade), cut a groove around the pipe on the mark you have made. The groove depth should be about 1/2 the thickness of the pipe you are cutting. When you have completed this groove, use an adjustable wrench, as shown in figure 1-73, to break away the unwanted material. The break should be clean, but if it isn't, file down the small ragged edges or cut the larger ones wit the hacksaw.

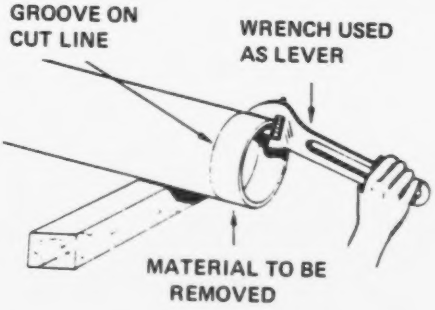


Fig 1-73. Breaking off cast iron pipe with an adjustable wrench.

We mentioned earlier in this study unit that cast iron soil pipe should last the lifetime of the building when installed properly. To insure a long life, the most important part of installing cast iron soil pipe is to insure that the joints are made properly and that they are leak free. There are three types of joints that can be used with cast iron soil pipe: the melted lead joint, the cold lead joint, and the compression joint. The melted lead joint is approved by all plumbing codes, whereas the cold lead joint and the compression joint are not.

To make this type of joint properly requires more equipment and experience than the other types but the melted lead joint will last longer than other types of joints. Before attempting to pour your first lead joint, certain precauctions must be taken under the direction of an experienced supervisor.

There are many different tools that you can use in making a melted lead joint. The tools used may look a little different but will serve the same purpose. The following discussion deals with the equipment and materials that you will probably find in the plumbing shop of a utilities section.

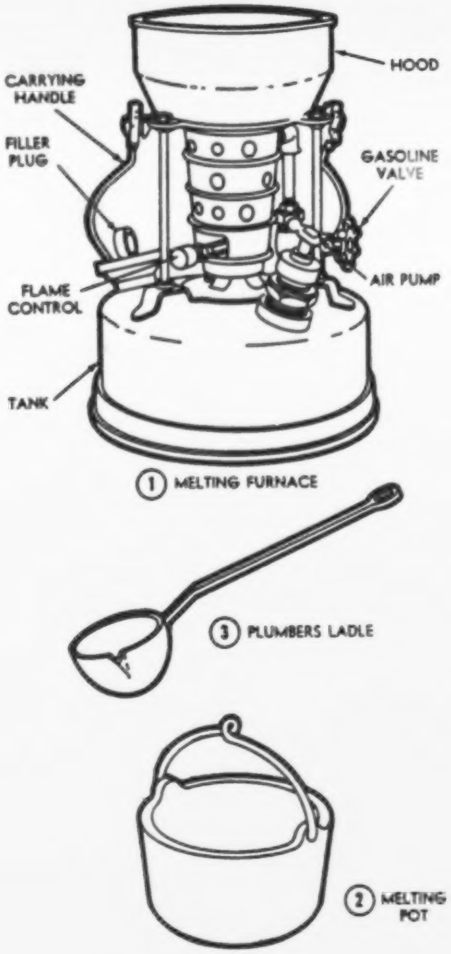


Fig 1-74. Melting furnance and accessories.

- Melting furnance: The melting furnace (fig 1-74) is a portable gasoline-burning furnance used to melt lead. Use caution when filling the tank with gasoline. Do not fill the tank when operating the furnance or when it is hot. You should not operate the furnance in an enclosed area.

- Melting pot: The melting pot (fig 1-74) is made of cast iron and is used to hold the lead while it is being heated on the hood of the furnance. Do not allow any foreign material to get into the melting post since this could contaminate the lead. Water and hot lead do not mix. Water can cause hot lead to splatter and may cause serious injuries.

- Plumber's ladle: The ladle (fig 1-74) is made of cast iron and is used to dip out the molten lead from the melting pot and carry it to the joint to be poured. The ladle has a pour spout that helps direct the flow of hot lead in a thin line to the joint.

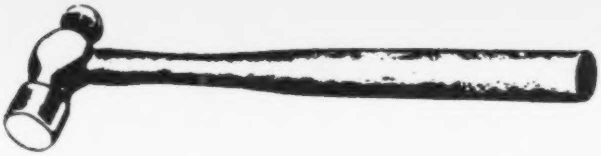
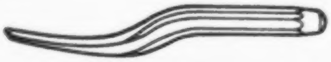
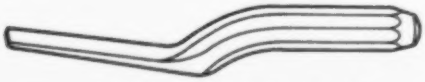


Fig 1-75. Ballpeen hammer.

- Packing tools: A ballpeen hammer (fig 1-75) is used as the striking tool when caulking a joint. These hammers range in weight from 4 oz to 2 lb. Usually a 6 oz or 8 oz hammer is sufficient or use when caulking lead joints.



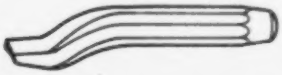
REGULAR PACKING IRON



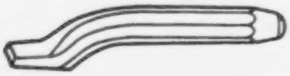
LARGE PATTERN PACKING IRON

Fig 1-76. Packing irons.

- Packing irons: These tools (fig 1-76) are used to tamp the oakum into the hub when making a join with cast iron soil pipe. These tools are sometimes referred to as yarning irons.



OUTSIDE CAULKING IRON



INSIDE CAULKING IRON

Fig 1-77. Outside and inside caulking irons.

- Caulking irons. Figure 1-77 shows outside and inside caulking irons. The inside caulking iron will insure that the lead joint makes a tight fit against the spigot end of the pipe, while the outside caulking iron will insure that the lead joint makes a tight fit against the hub end of the joining pipe. These caulking irons are used to drive the poured lead or lead wool into a joint (to be discussed later).

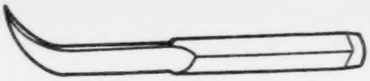


Fig 1-78. Pickout iron.

- Pickout iron. The pickout iron (fig 1-78) is used to remove lead and oakum from a made-up joint, if necessary.

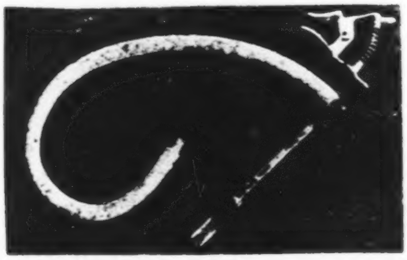


Fig 1-79. Asbestos joint runner.

- Asbestos joint runner (fig 1-79): This tool is used when making a horizontal or upside-down vertical caulked joint. The joint runner helps to keep the lead inside the hub.

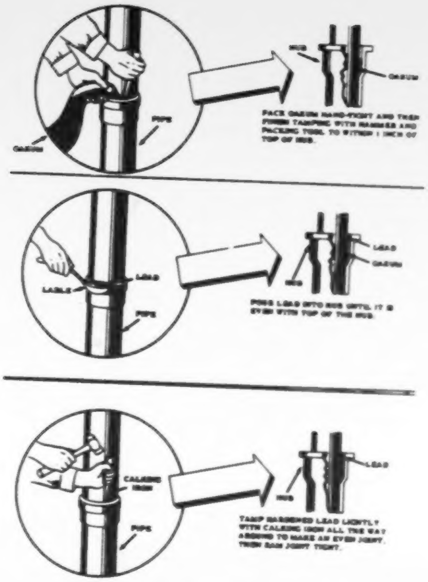
All joints in a plumbing system must be made water tight and gas tight. Oakum and lead, when properly used in a cast iron soil pipe joint, produce a long lasting watertight and gastight joint.

- Oakum. Oakum is a fiber material made of hemp or jute fibers that are impregnated with a tar compound and loosely twisted or spun into a rope or yarn. (With a 3-inch cast iron pipe, you would need approximately 4 1/2 feet of oakum.) Oakum is packed between the hub and spigot to within 1 inch (2.54 centimeters) of the top of the hub (fig 1-80). The molten lead is the poured on top of the oakum and packed.

- Lead. Lead is usually available for melting in cakes or ingots ranging from 1 pound on up. The lead is melted and poured into the joint (fig 1-80).

There are three types of joints that can be made using the melted lead method: the vertical caulked joint, the horizontal caulked joint, and the upside-down caulked joint.

- Vertical caulked joints (fig 1-80). First wipe clean the thumb and spigot to be joined. Remove any moisture from them by using a torch. Join them together by sliding the spigot end into the hub. When using a cut end, you must take care to center it in the hub. Next, twist a short length of oakum and pack it into the joint using the yarning iron. Continue this process until the oakum is packed tightly 1 inch from the top of the hub. Next, using the plumber's ladle, carefully pour the melted lead into the joint until it rises slightly above the edge of the hub. Never use two pours in a joint; always make it in one pour. Allow a couple of minutes for the lead to harden. Next caulk the joint using firm but light hammer blows. First use the outside caulking iron and caulk all the way around the joint. Next, using the inside caulking iron, caulk all the way around the joint. Do not caulk the lead too tightly because this may crack the joint.

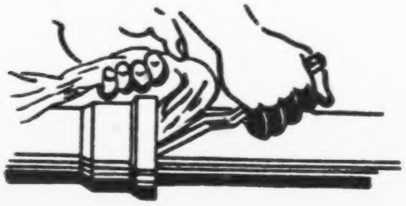


PACK OAKUM HAND-TIGHT AND THEN FINISH TAMPING WITH HAMMER AND PACKING TOOL TO WITHIN 1 INCH OF TOP OF HUB.

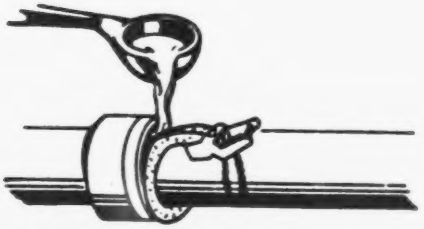
POUR LEAD INTO HUB UNTIL IT IS EVEN WITH TOP OF THE HUB.

TAMP HARDENED LEAD LIGHTLY WITH CALKING IRON ALL THE WAY AROUND TO MAKE AN EVEN JOINT. THEN RAM JOINT TIGHT.

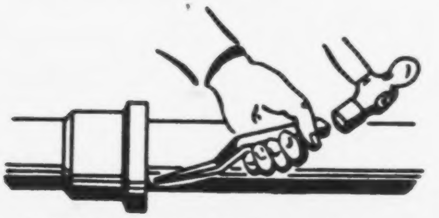
Fig 1-80. Vertical caulked joint.



PACK JOINT HALF FULL OF OAKUM.



CLAMP JOINT RUNNER AROUND PIPE AND POUR LEAD INTO JOINT.



REMOVE JOINT RUNNER WHEN LEAD HAS COOLED AND CAULK JOINT.

Fig 1-81. Pouring horizontal joint.

- Horizontal caulked joint (fig 1-81). First, prepare and pack the joint with oakum as previously explained. Next, place the asbestos runner around the pipe. The spring clamp holds the runner on the pipe and is positioned on top of the joint. Using a hammer, lightly tap the runner against the hub. This will prevent the lead from running out of the joint. Place a small amount of oakum under the spring clamp where the two ends of the runner meet. This keeps the melted lead from running out at this point. Pour the lead into the joint until it fills the open space in the runner. Allow a couple of minutes for the lead to harden, then remove the runner. Using a chisel, remove the lead left by the opening in the runner. Caulk in the same manner as explained above, except use the inside caulking iron first.

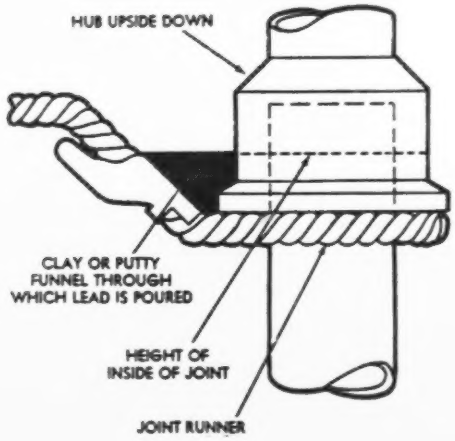

HUB UPSIDE DOWN
CLAY OR PUTTY FUNNEL THROUGH WHICH LEAD IS POURED
HEIGHT OF INSIDE OF JOINT
JOINT RUNNER

Fig 1-82. Making an upside-down joint.

- Upside-down caulked joint (fig 1-82): This joint is prepared in the same manner as explained above. However, as shown in figure 1-82, a funnel is made with clay, putty, or mud. After the pour, the runner is removed while the lead is still soft. The surplus lead left by the runner is trimmed, and then the lead is caulked with a stub caulking iron. This is done while the hot lead is still soft enough to be adjusted against the walls of the hub. It is caulked in the same manner as a vertical joint.

Although the most widely approved type of joint is the melted lead joint, there are two other types of joints which may be used by the Marine plumber if the need arises. We shall discuss the cold lead joint and compression joint. The local plumbing code will indicate if it is possible to use one of these other types of cast iron soil pipe joints.

- A cold lead joint. A cold lead joint can be made for joining cast iron soil pipe. This method is not recommended, but it can be used in an emergency or when the tools are not available. Lead wool or shredded lead is packed on top of the packed oakum to complete the joint. The same packing tools used for the melted lead joint are also used for this type of joint.

- Compression joint. This is an easy joint to make; however, check the local plumbing code to see if it is an acceptable type of joint. This joint is made with a neoprene compression gasket (fig 1-83). The gasket is first inserted into the hub end of a piece of pipe. The spigot or plain end of a connecting pipe or fitting is then forced into the hub. As you can see, there is little need for oakum or lead to prepare this type of joint.

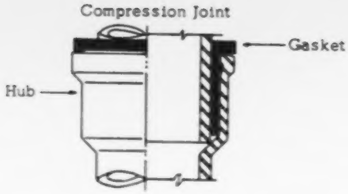


Fig 1-83. Compression joint.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. That part of a plumbing installation which carries unwanted solids and liquids to an area where it is treated and disposed of is called the __________ system.
2. What is the most durable type of pipe that can be used for waste systems?
3. In what two weights are cast iron soil pipe and fittings available?
4. In what sizes are cast iron soil pipe and fittings available?
5. Cast iron soil pipe is available in lengths of __________ feet.
6. What are the most often used sizes of cast iron pipe and fittings?
7. Some of the common types of cast iron fittings that you will work with are beds, branches and __________
8. What type of cast iron fitting can also be referred to as an elbow fitting?
9. The three tools that can be used to cut cast iron soil pipe are the hammer and chisel, the pipecutter, and the __________
10. Which type of measuring device should be used when measuring cast iron soil pipe?
11. When cutting cast iron soil pipe, which method requires the use of a board or mound of earth to support the pipe?
12. You find it necessary to cut only one inch off a length of cast iron soil pipe. What tools should be used for this purpose?
13. What type of joint when made properly will last longer than the other types?
14. When joining cast iron soil pipe, all joints should be made __________

Matching: In the group of items below (item 15-19), match the type of joint in column 1 with the method of joining in column 2. Place your answer in the spaces provided.

Column 1

Type of joint

15. _____Upside down caulked joint

16. _____Lead wool or shredded lead point

17. _____Vertical caulked joint

18. _____Neoprene gasket joint

19. _____Horizontal caulked joint

Column 2

Method of joining

a. Melted lead method
b. Cold lead method
c. Compression method

Work Unit 1-4. COPPER TUBING AND FITTINGS

IDENTIFY HOW COPPER TUBING AND FITTINGS CAN BE USED.

GIVEN A LIST CONTAINING SEVERAL CHARACTERISTICS OF COPPER TUBING, IDENTIFY EACH CHARACTERISTIC AS BEING AN ADVANTAGE OR DISADVANTAGE.

IDENTIFY THE SIZES IN WHICH COPPER TUBING IS AVAILABLE.

IDENTIFY TOOLS USED TO CUT AND BEND COPPER TUBING.

IDENTIFY THE PROCEDURES FOR CUTTING AND BENDING COPPER TUBING.

IDENTIFY THE METHODS OF JOINING COPPER TUBING AND FITTING.

Assume that you are working at a Marine Corps installation and are told to design a plumbing installation for a new building. You are told that this plumbing system must last a long time, and the amount of money spent is not a factor. The type of material selected should be relatively easy to install and of the type that can be used throughout the installation. What type of material would you use? If you said copper, you are correct. Copper is probably the most versatile plumbing material used today. This work unit will be concerned with the uses, advantages and disadvantages, and availability of copper pipe and tubing. The tools and procedures used to cut and join copper pipes tubing will also be discussed.

Rigid copper tubing is sometimes called copper pipe in the plumbing field. The term copper pipe will be used in this work unit to designate the rigid, hard-tempered copper tubing. The soft-tempered copper tubing will be referred to as flexible tubing. Copper pipe requires fittings when a bend or turn is necessary, whereas, flexible tubing can be bent as necessary.

Copper pipe and tubing can be used anywhere that iron, plastic, and cast iron soil pipes and fittings are used. There are several advantages and few disadvantages in using copper tubing. Copper pipe and flexible tubing are used in all types of buildings for hot and cold water distribution systems and for waste, vent, and drain lines. Copper plumbing materials can be used in all general military plumbing applications.

The advantages of using copper pipe/flexible tubing over some other type of material in a plumbing system far outweight the disadvantages. The following are some of the advantages.

- Weight: The only other plumbing material that is lighter than copper is plastic. The light weight of copper does not mean that is is not strong. Copper pipe and flexible tubing can be used in most plumbing applications and are accepted by most plumbing codes. Applications where you cannot use copper will be discussed later in the work unit. Because of its light weight, copper is easier to handle and requires less time and effort to install than heavier materials.

- Resistance to corrosion: Because of its high resistance to corrosion and long life, copper is a favored material for the plumber who wants a plumbing installation to perform and look like new over a long period of time.

- Ease in installation: Another advantage of using copper tubing is the relative ease of installation. Once the types of joints used are mastered, copper is probably the type of material that can be joined most quickly.

As was stated earlier, the disadvantages of using copper in plumbing installations are few but these disadvantages could be enough to discourage the use of copper in some types of installations.

- Cost: Copper is very expensive. Because of high initial cost, many people are reluctant to consider copper for a new installation. When the facility may be of a temporary nature, copper should not be used because of its high cost. Another type of material (plastic) should be used in temporary installations where the plumbing codes allow..

- Lack of resistance to damage: Because copper is relatively soft, care should be taken to use it in areas where there is no chance of accidental impact damage. In general, copper should not be buried because of the chance of it being flattened by a heavy load (such as a truck) and because the chemical content of some soils is such that it reacts with the copper to cause corrosion (similar to rusting in iron pipe). The only type that can be buried is type K which will be discussed below.

Copper pipe (rigid tubing) is available in lengths of 12 feet and 20 feet. The pipe is measured by an outside diameter (O. D.) and is available in sizes from 1/4 inch to 8 inches. Figure 1-84 shows cut pieces of copper pipe in various diameter sizes.

Fig 1-84. Copper pipe.

The types of copper pipe that are available for the Marine plumber are types K, L, M, and DWV.

- Type K: This type of tubing is used for heavy-duty installations where the pipe is to be laid underground or buried in concrete. Type K tubing has a heavy wall that can withstand additional stress and is available in both rigid and flexible tubing.

- Type L: Type L tubing is used where the conditions are not as severe as the conditions requiring type K tubing. Type L has a medium wall and is used for general interior plumbing work. This type is available in rigid and flexible tubing.
- Type M: This type of tubing, which is available in rigid tubing only, has a thin wall and is used principally for hot water heating systems.
- Type DWV (drain, waste, vent): This type of tubing is used only for above-ground drain, waste, and vent lines. Type DWV comes in rigid tubing only and in sizes ranging from 1 1/4 inches to 8 inches O.D. and in lengths of 12 feet or 20 feet.

Flexible copper tubing (fig 1-85) is available in coils of 40 feet to 100 feet, depending on the diameter. The smaller diameter tubing comes in the longer coils. For an explanation of the types available, refer to the paragraph above.

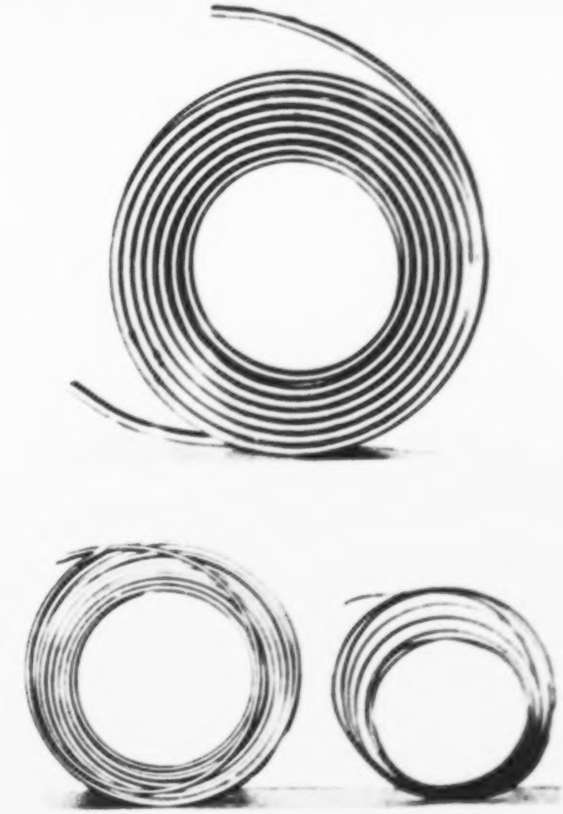


Fig 1-85. Flexible copper tubing.

Copper fittings are prefabricated plumbing parts that are used to form joints or change the direction of copper pipe or tubing.

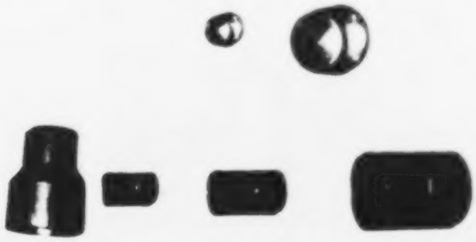


Fig 1-86. Adapters (copper to steel).

These fittings are used when joining copper to another type of metal. Figure 1-86 shows adapters that are used when joining copper tubing to steel pipe. One end of the adapter is soldered or sweated on the copper tubing, and the other end is threaded on the steel pipe. Figure 1-87 shows an adapter that can be used when it is necessary to join copper tubing to cast iron pipe.

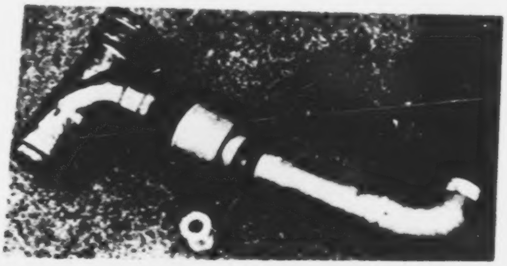


Fig 1-87. Adapter (copper to cast iron).
(If copper closet bend must connect into a cast iron soil stack, an adapter, in center, is used.)

There is a complete line of valves and faucets that can be used to control or stop the flow of liquid when installing copper tubing. These valves are similar to the valves that were discussed in the first chapter. The only difference is in the way the joint is made. In copper installations, the joint is soldered. Figure 1-88 shows a valve that has been sweated to copper pipe. These valves can also be used on flexible tubing.

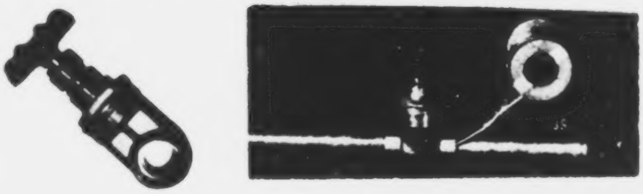


Fig 1-88. Valve sweated on copper pipe.

Copper pipe can be joined only by soldered joints. Flexible tubing can be joined by either soldered joints or compression//flare joints. The most durable type of joint is the soldered joint, and some plumbing codes specify soldered joints for installation inside of walls. If there is a need to join copper to another type of plumbing material (such as cast iron), there are special adapters available to make possible the joining of different materials.

Soldered joints can be used for both rigid and flexible tubing. Figures 1-89 and 1-90 show examples of soldered joints.

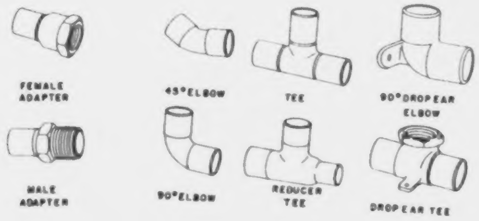


Fig 1-89. Soldered-type pipe fittings.

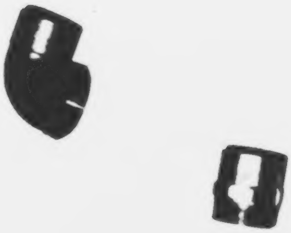


Fig 1-90. DWV soldered fittings.

As the name implies, soldered fittings require soldering (sweating) for joining. This procedure will be discussed in the following paragraph.

Flare-type joints have a threaded collar that can be drawn up as tightly as required with a wrench. Figure 1-91 shows a compression-type joint. The procedure for making a compression or flare-type joint will be discussed in paragraph 4-8a. A flare must be made on flexible tubing to accommodate the bevel on the fitting. This procedure will be discussed in the following paragraphs.

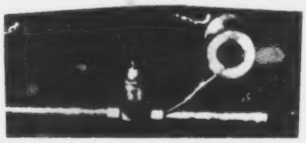


Fig 1-91. Compression/flare-type fittings.

The different types of copper tubing and the availability of copper plumbing materials have been discussed. Another important part of the plumbing job includes the measuring, cutting, and bending of copper tubing. If you do not use proper measuring, cutting, and bending techniques when working with copper materials, there is a good chance that you will waste material or that your job will not look good. There is also the possibility that your plumbing installation will not function properly. In the following discussion, the tools and procedures used to measure, cut, and bend copper tubing will be covered.

Correct measurements are necessary to eliminate waste and to insure proper fit. Remember that the copper tubing you are working with is very expensive. As a Marine plumber, you will have available two measuring tools, the flexible steel tape and and the folding steel rule. These measuring tools are of the same types as those discussed in the first chapter of this text and are used in the same manner.

Note: Remember that when measuring tubing prior to cutting, you must allow for that part of the tubing which will be inserted into the fitting. A further discussion of this procedure will come later in this work unit.

As a Marine plumber, there are two ways you can cut copper tubing (flexible or rigid). You can use either the hacksaw (fig 1-92) or tubing cutter (fig 1-93).

Hacksaw: An ordinary hacksaw can be used in the cutting of copper tubing. The hacksaw is the same type used to cut cast iron pipe in the previous chapter. To make a straight cut (90°) on the tubing face, it is recommended that you use a jig to hold the tubing and to align the hacksaw. Figure 1-92 shows a simple jig that can be made to cut tubing. After the cut is made, the small burrs (ragged edges) left inside the tubing should be trimmed with a pocketknife (fig 1-92). The outer burrs should be removed with a file (fig 1-92) and steel wool should be used to clean the tubing before joining.

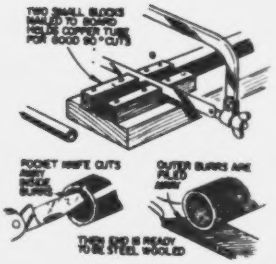

TWO SMALL BLOCKS NAILED TO BOARD HOLDS COPPER TUBE FOR GOOD 90° CUTS
POCKET KNIFE CUTS AWAY INSIDE BURRS
OUTER BURRS ARE FILED AWAY
THEN END IS READY TO BE STEEL WOOLED

Fig 1-92. Cutting copper tubing with a hacksaw.

- Tubing cutter: Another tool that the Marine plumber can use to cut copper tubing is the tubing cutter. Figure 1-93 shows a tubing cutter with attached reamer used to ream the burrs or ragged edges from the cut end of the tubing after cutting.

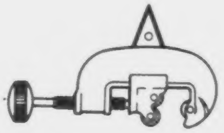


Fig 1-93. Tubing cutter with reamer.

This tool is similar to the single wheel steel pipe cutter but is much lighter. It is used in the same way as the pipe cutter discussed in work unit 1. This is the neatest and quickest way to cut copper tubing.

Note: Do not tighten down too hard on the cutting wheels when making turns around the tubing. The cutting wheels should be firm but not extremely tight because this causes the tubing to be pushed into the cut opening. This increases the amount of copper excess to be reamed out. Insure that the cutting wheels are sharp because dull or chipped wheels will have the same effect on the tubing as overtightening the cutter.

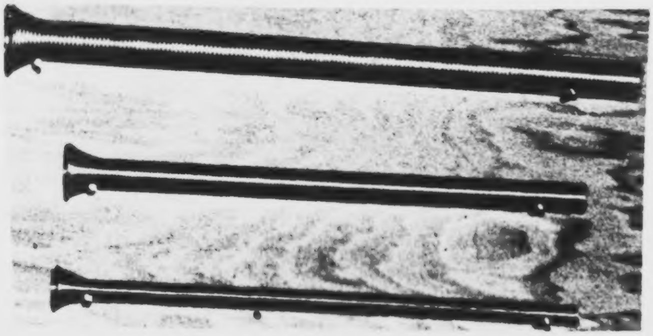


Fig 1-94. Spring-type tubing benders.

The spring-type tubing bender (fig 1-94), makes smooth bends in flexible copper tubing (remember that rigid tubing cannot be bent). The spring bender is available for different sizes of tubing and is simply pushed over the tubing in the area where you desire the bend. The tubing is then bent by hand to the desired form (the spring prevents the tube from collapsing). when you have the bend desired, pull the spring bender off the tubing. Do not attempt to make bends in flexible tubing without the aid of a bender. The job will be much neater looking with a spring bender, and the waste from twisted and collapsed tubing will be kept to a minimum.

The most critical phase of installation is the proper joining of pipes and fittings. If you do not do this phase of your work properly, leaks and/or stoppages are likely to occur. The compression/flare joint, the compression fitting, the soldered/sweated joint,and the tools and procedures used in copper installations will be covered in this paragraph.

- Compression/flare joint: This type of joint is used with flexible tubing only. the fitting to which the copper tubing will connect has a beveled end. Because of this, the cut end of the tubing must be flared in such a manner as to cover this bevel. A flaring tool must be used when making the flare. The nut on the threaded coupling of the fittings is drawn up tightly with a wrench, compressing the beveled portion on the fitting to the "flare" of the tubing, thereby making a compression joint.

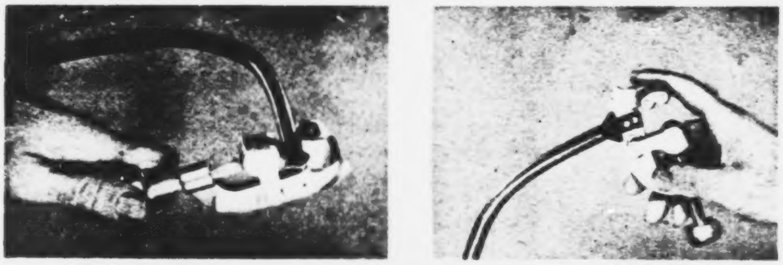
- Compression fitting: To eliminate the need for a flaring tool when just a few joints have to be assembled, a compression fitting can be used with copper tubing. (This is not to be confused with the compression/flare joint.) A tapered ring is slipped over the end of the tubing after the retaining nut is on. When the two halves of the compression fitting are tightened, the ring is squeezed tightly on the outside of the tubing to form a watertight seal.

- Soldered/sweated joint: This type of joint can be used on rigid or flexible tubing. The soldered joint is the most durable joint, and some parts of a plumbing installation require soldered joints. Soldered joints require the use of a specific type of solder. Usually a 50-50 solder is used. This means the solder is made up of 50% tin and 50% lead. This solder comes in small coils. Most factory-made joints are made with 95-5 solder. This type of solder is know as silver solder because it contains 95% tin and 5% silver. The 95-5 solder is the strongest solder available. Soldered joints also require the use of a flux. This is a paste-like material that is put on the joint surfaces after they have been cleaned and prior to applying heat and solder. The flux aids the flow of solder into the joint and reduces oxidation (similar to rust in steel pipes) of the metals. Soldered joints require the the use of a torch to heat the join for soldering. Acetylene torches, blow torches, or propane torches should be used for this purpose.

There are very few tools needed to join copper tubing. With practice and experience, you will improve your technique and will probably agree that this type of joint is the easiest and quickest type to make. the following tools and procedures are used in joining rigid and flexible copper and tubing when using the soldered/sweated and soldered compression/flare joints.

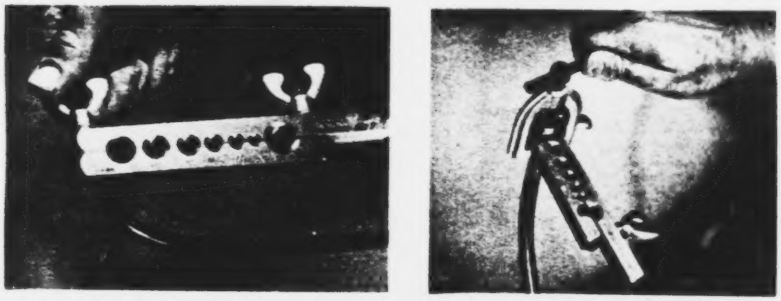
- Compression/flare: This type of joint was discussed briefly earlier in this chapter. After you cut and ream the flexible tubing, you are ready to begin the flaring procedure (see figure 1-95) for a step-by-step explanation). When reaming the tubing, remember that the smoother the inside edge of the tubing is, the better the flare joint will be. The inside edge is the part of the tubing that will be flared and will make the compression contact with the bevel on the fitting. So, the smoother, the better. Now you are ready to clamp the tubing to the flanging tool.

Note: You must slip the flare nut over the tubing before you clamp it to the flanging tool. It can be very irritating and time wasting if you make a good flare and, after finishing, find that you have forgotten to slip on the flare nut. If you make a flare without having the flare nut on the tubing, there is just one way to connect it. You have to cut off the flare and start all over again. So, think about that nut before you begin to flare the tubing.



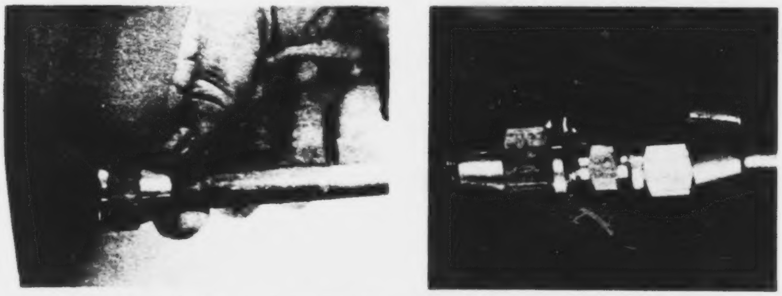
When cutting flexible copper tubing, work carefully to avoid squeezing tube out of round. Turn hand screw to tighten cutter half turn at a time.

Burrs that are left on the inside of copper tube after it has been cut can easily be removed with burr-removing attachment on most tubing cutters.



To flare the tubing with a flanging tool, clamp the tube end in appropriate size hole in the die and turn wing nut on the side to lock it tight.

Flaring tool is now clamped into place over the die so that tapered point is in line with tube end. Turn of hand screw will flare tube neatly.

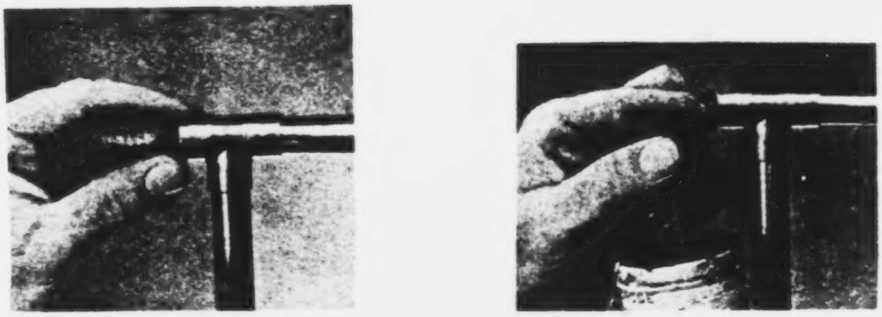


After tube end has been flared, slide flanged retaining nut back up to tube end. This nut was placed over tubing before the flaring operation.

The flared coupling joint is assembled with two wrenches. One wrench is used to hold nut on one side, while the other side is tightened up snug.

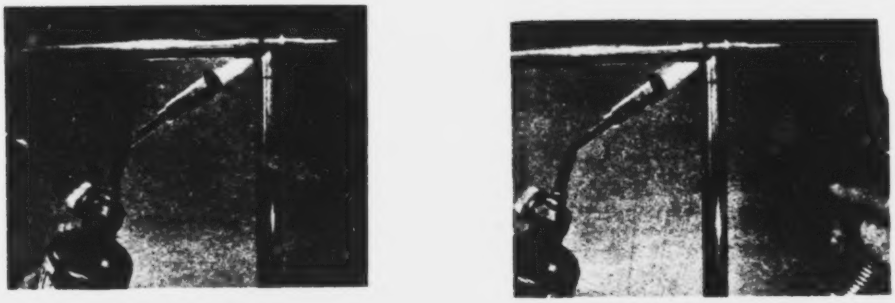
Fig 1-95. Preparing a compression/flare joint.

Place the tubing in the appropriate size of hole in the flanging tool flush with the face for the tool, and secure by tightening the wing nut. The flaring tool is now placed over the clamp and, by turning the hand screw of the flaring tool, a flare is made in the tubing. The nut is now tightened on the fitting. This type of fitting is easily cross-threaded, so align your tubing and fitting as accurately as possible and then start the flare nut by hand. After the nut has been screwed on at least two threads, use an appropriate sized, open-end wrench to tighten the joint.



Use steel wool to clean the end of the pipe and inside the fitting before soldering. Rub metal till bright and shiny, then wipe with clean cloth.

After the metal is clean, spread a thin layer of flux onto the end of pipe. Flux should also be applied to the inside of fitting, as shown here.



Heat assembled joint before applying the solder. Direct flame at center of fitting, and heat till metal is hot enough to melt solder on contact.

Aim flame at fitting and apply end of solder to open end of fitting. Capillary action will suck the solder in, even when the joint is vertical.

Fig 1-96. Preparing a solder joint.

- Soldered/sweated (refer to fig 1-96): You need heat to make this joint. You can use an acetylene torch, a blow torch, or a propane torch for this purpose. You will need flux and 50-50 solder. After you have cut the tubing to the proper length and have removed the burrs, clean the end with steel wool until it is shiny. Clean the inside of the fitting the same way. Next, wipe the end of the tubing and fitting with a clean cloth. Dryfit the joint to insure a good fit. The tubing should enter all the way to the shoulder of the fitting. Now apply a thin layer of flux to the end of the tubing and the inside of the fitting. Push the end of the tubing into the fitting and turn it back and forth a few times to make sure that the flux is evenly spread. Wipe off the excess flux, which may ooze out, before you apply heat to the fitting.

Heat the assembled joint with a torch. Heat the joint uniformly by directing the flame of the torch around all sides of the fitting--NOT ON THE TUBING. Concentrate the flame on the heaviest part of the fitting. When the flux starts to bubble and melt, this is an indiction that the joint should be hot enough to apply the solder. the melted solder will be drawn into the joint by capillary action. Keep turning the flame back to the fitting and applying the solder until the joint is filled. When a bead ring forms on the end of the fitting and tubing, the joint has enough solder.

Note: In soldering valves on a copper line, remove the stem to keep washers from scorching when heat is applied (fig 1-97).

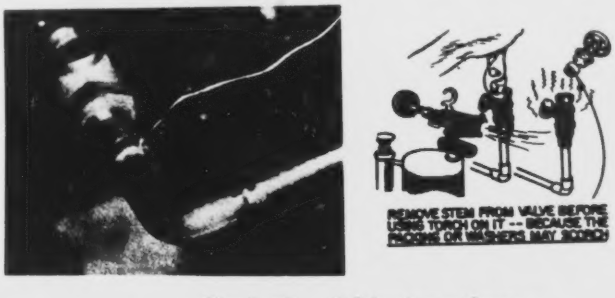

REMOVE STEM FROM VALVE BEFORE USING TORCH ON IT -- BECAUSE THE PACKING OR WASHERS MAY SCORCH

Fig 1-97. Soldering valves.

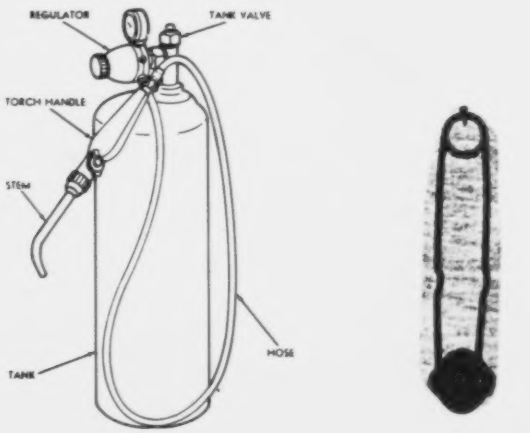


Fig 1-98. Acetylene torch with igniter.

- Acetylene torch: The acetylene torch is one of the tools used to heat copper tubing and fittings for soldered joints. Figure 1-98 shows some of the torch controls you should become familiar with. The tank valve controls the flow of gas from the tank to the regulator. The pressure regulator is adjustable so you can control the pressure at the stem tip. The torch is lighted by turning on the tank valve and the handle control valve until gas escapes from the stem tip. You can use the spark lighter (fig 1-98) or a match to ignite the gas. You adjust the regulator to get the flame desired (pale blue with a bright inner cone). A pilot flame can be produced by opening the small valve in the center of the handle control valve.When you shut off the handle valve, the small pilot flame will stay lit. This automatically puts a soldering flame on when you turn the handle control valve on again.

- Blow torch (fig 1-99): The blow torch uses gasoline as fuel. Pressure is obtained by pumping air into the tank body with the small thumb-operated pump on the side of the blow torch. When the control valve is turned on, gas droplets are forced out of the tank. The blow torch is then ignited using a flame. The torch must be warmed up before it has the proper flame for soldering. This means that after you initially light the blow torch, it takes a few minutes for the generator to heat up enough to emit a clean-burning blue flame.

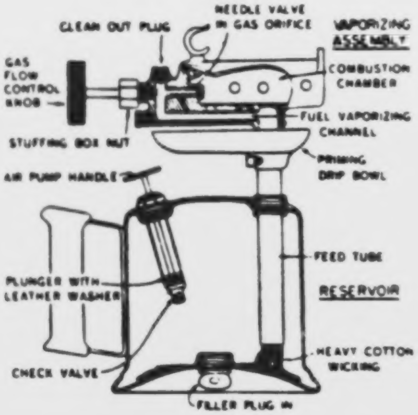


Fig 1-99. Blow torch.

- Propane torch (fig 1-100): This tool is available with different sizes of tips for different jobs. The small propane gas cylinder can be bought separately when empty (cheaper to get filled). The tips are screwed on the cylinder head and the flame is controlled by using the shut-off valve on the stem. To light propane torch, simply turn on the valve and light the propane gas escaping from the tip with a match. In figure 1-96 a propane gas torch is being used for soldering a joint.

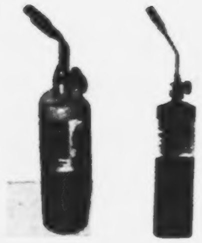


Fig 1-100. Propane torch.

Note: All of these torches should be handled with care. If you have never used one of these torches, you should seek an experienced Marine plumber to show you the operating and safety techniques involved. These tools should not be used where there is poor ventilation. Gas cylinders should not be left in the hot sun. Extreme pressure could build up in the cylinders and cause them to explode. Safety goggles should be worn when soldering as a precaution against eye injuries. Serious burns can also occur if you handle heated copper with bare hands. You must be extremely careful in this phase of your plumbing job.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Which plumbing material is probably the most versatile of those used today?

2. Which type of plumbing material could a Marine plumber feel confident in using in all general plumbing installations?

3. Copper pipe and tubing are used in all types of buildings for ____________________

IDENTIFICATION: In the items below (items 4 to 7) identify each characteristic of copper taking as either an advantage or disadvantage. Place your answers in the spaces provided.

4. ____ Installation procedures
5. ____ Cost
6. ____ Weight
7. ____ Resistance to damage

a. Advantage
b. Disadvantage

8. You can obtain copper pipe in lengths of 12 feet and ____________________ feet.

9. Which measurement(s) should you use to indicate the diameter of copper pipe?

10. Which are the two types of copper tubing available to the Marine plumber?

11. Copper tubing is available in coils of ________________ and ____________ feet.

12. When cutting and bending copper tubing, the tubing bender, the copper tubing cutter, and the ____________ should be used.

13. Which tool provides the quickest and neatest way to cut copper tubing?

14. The copper tubing bender allows you to bend flexible copper tubing without ________

____

15. When measuring copper tubing prior to cutting it, you should consider the ________

____

16. What should be used to hold the copper pipe or tubing when cutting with a hacksaw?

____

17. A straight cut on the tubing face should be at a ____________ angle.

18. When bending copper tubing, you should always use a ____________________

19. The two types of compression joints are the compression/flare and the compression

____

20. What type of solder will the Marine plumber usually use when soldering a copper joint?

____

21. When making a soldered joint, which material must be used to reduce oxidation?

____

22. When placing the tubing in the flanging tool prior to flaring for a flare joint, the tubing must be ____

23. What must be done to valves prior to soldering?

____

24. The most durable type of joint and the type often specified when running tubing between walls is ____.

25. You have been told to complete an installation of copper tubing, and you find that you have to join a length of rigid copper pipe to steel pipe. How would you accomplish this?

____

SUMMARY

In this study unit, you have been introduced to the uses, advantages and disadvantages, availability, and installation of copper tubing. You have found that copper is expensive but very durable and can be used in most types of plumbing applications. Copper is lightweight, easy to install, and available in both rigid and flexible types. There are many types of copper fittings, tools and procedures for measuring, cutting, and bending copper tubing, and methods for joining used in the installation of copper tubing. You should use extreme care when working with copper tubing because of the expense of the copper and the dangers involved in many of the joining methods.

Answers to Study Unit #1 Exercises

Work Unit 1-1.

1. hard to work with.
2. new installations.
3. 21 feet
4. unthreaded.
5. 1/8
6. To supply potable water to a building.
7. Cold water distribution system
8. Hot water distribution system
9. By the thickness
10. Standard weight
11. Industry
12. steel measuring tape.
13. self-locking pipe vise.
14. Wheel type pipe cutter
15. inside diameter.
16. Pipe reamer
17. Die and die stock
18. sulphur.
19. Liberally
20. joining of pipe.
21. To ensure a tight fit
22. antiseize/ teflon tape.
23. chain tongs.
24. Chain wrench
25. that are of the same size.
26. Has threads on both ends
27. disconnect the pipe.
28. Adapter
29. 45^o and 90^o elbow.
30. regulating the flow.
31. flow in one direction only.
32. regulate the flow.
33. A gate valve permits a flow of water and is either open or closed.
34. The valve can be drained.
35. provides a liquid seal.
36. plumbing codes.

Work Unit 1-2.

1. c
2. d
3. a
4. flexible
5. 10 and 20 feet.
6. Low resistance to impact
7. ease of handling.
8. miter box.
9. Small diameter
10. Flexible
11. Dry fit
12. male end of the pipe.
13. c
14. d
15. b
16. a
17. unthreaded
18. spigot
19. 1, 2, 3 .
20. 90^o
21. drain and sewage systems.
22. PE pipe.
23. brass.

Work Unit 1-3.

1. waste
2. Cast iron
3. Standard and extra heavy
4. 1-1/4 inch I.D. and up
5. 5
6. 2, 3, 4 inches
7. tees.
8. Bend
9. hacksaw.
10. Steel tape
11. Hammer and cold chisel method
12. Hacksaws and adjustable wrench
13. Melted lead method
14. watertight and gastight.
15. a
16. b
17. a
18. c
19. a

Work Unit 1-4.

1. Copper
2. Copper
3. hot and cold water distribution systems.
4. a
5. b
6. a
7. b
8. 20
9. O.D. (outside diameter)
10. Rigid and flexible
11. 40 feet and 100 feet.
12. hacksaw
13. Tubing cutter
14. collapsing the tube.
15. distance that tubing will be inserted into the fitting.
16. Jig
17. 90°
18. tubing bender.
19. fitting.
20. 50-50
21. Flux
22. clamped flush with the face of the tool.
23. Remove the stem.
24. soldered.
25. Use an adapter for copper to steel.

STUDY UNIT 2

WATER SERVICE

STUDY UNIT OBJECTIVE: WITHOUT THE AID OF REFERENCES, YOU WILL IDENTIFY THE WATER SERVICE USED BOTH IN GARRISON AND IN THE FIELD. YOU WILL IDENTIFY THE VARIOUS ASSOCIATED FIXTURES, AND THE CERTAIN TYPES OF TOOLS USED TO INSTALL PLUMBING FIXTURES. IN ADDITION YOU WILL IDENTIFY THE SAFETY PRECAUTIONS THAT YOU MUST FOLLOW WHEN USING THESE TOOLS.

There is a system of pipes in a plumbing installation that carries potable (drinkable) water from the street main to the fixtures in the building. This system of pipes and many of the associated fixtures (water closets, urinals, lavatories, sinks, showers, and drinking fountains) will be discussed in this portion of the course. The Marine plumber (Hygiene Equipment Operator) in the field does not always have the time, equipment, or materials to install the types of fixtures found in the garrison, so improvised fixtures (field expedients) are usually constructed. Certain types of tools are used to install plumbing fixtures in the garrison and in the field. The safety precautions to follow when using these tools will also be covered in this study unit.

Work Unit 2-1. WATER SERVICE

IDENTIFY THE MAIN SUPPLY PIPE SIZE FOR BUILDING AND WATER SUPPLY LINES.

IDENTIFY THE MOST IMPORTANT FACTOR TO BE CONSIDERED WHEN IN SPECIFYING THE SIZE OF THE INDIVIDUAL FIXTURE FEED PIPE.

IDENTIFY THE FACTORS USED IN CALCULATING THE SIZE OF THE WATER SERVICE LINE.

One of the objectives of plumbing is to move potable water to a desired location in a building or other area. The water is carried by pipelines which must meet certain standards or codes. This study unit will be concerned with both the water service line that delivers potable water to the desired building or area and those lines (feeders) that branch from the service to feed the fixtures located within that structure.

The water service line is that part of the system which carries water from the street main to a desired building. The water carried by the service line feeds into the fixture feed lines. The water service line can be made of any of the materials previously described (steel, copper, etc.). The water service line is usually the same size as the main supply line but in some cases may be larger.

The purpose of the water service line is to provide enough potable water to supply the needs of the building. The water service line must be of adequate size to meet all fixture demands.

Selecting the proper size for the service line is an important step in planning a plumbing installation. Factors which determine service line size are as follows:

- The water pressure in the line.
- Total gallons per minute (gpm) needed for the fixtures.
- Simultaneous use factors.
- Length and number of bends in the pipe (pipe friction).

By keeping in mind the water pressure when sizing the line, you can help prevent leaks and damaged faucets and valves.

Note: Usually a 40-55 pound per square inch (psi) pressure is utilized in the water service line. If pressures over 60 psi are encountered, a pressure reducing valve must be installed at the entrance of the service line of the building.

The total amount of water that would be needed to supply all fixtures if they were being used simultaneously for 1 minute is called the **maximum fixture demand**. Figure 2-1 shows different fixtures with the maximum fixture demand of each in gallons per minute (gpm).

Fixture	Units	Gallons per minute
Water Closet	6	45
Urnial	5	39-1/2
Slop sink	3	22-1/2
Shower	2	15
Laundry tray	2	15
Bathtub	2	15
Kitchen sink	2	15
Lavatory	1	7-1/2

Fig 2-1. Maximum fixture demand.

Since it is highly improbable that all fixtures will be turned on at once, a probable percentage of the fixtures which will be in use at any given time must be determined. The factor of simultaneous use is a figure which must be estimated. Figure 2-2 shows an estimation of probable demand. When using it, take the actual number of fixture installed, not the fixture unit valve. Use the higher portion of the percentage ranges for the lower portion of the number of fixture ranges.

Note: For a practical purpose, a plumber can estimate that 30% of the fixtures in any given installation will be in use at the same time.

Number of fixtures	Percent of simultaneous use
1 - 5 -	50 - 100
5 - 50 -	25 - 50
50 or more -	1 - 25

Fig 2-2. Factors of simultaneous use.

Other factors that must be considered in sizing pipe are the length of the pipe in the building and the number of turns in the pipe. The longer the pipe, the greater the resistance to flow. This resistance is called pipe friction.

Note: Friction loss. Because of friction loss in pipe and fittings, water may lose its pressure. To determine the proper pipe size would involve a number of complicated calculations. Therefore, approximate figures acceptable for the military plumber are shown in figure 2-2.

3/8 inch pipe

Pressure at source in pounds per square inch	Length of pipe in feet									
	20	40	60	80	100	120	140	160	180	200
10	5	3	3	2	2	2	---	---	---	---
20	9	5	4	3	3	3	2	2	2	2
30	10	6	5	4	4	3	3	3	3	2
40	---	8	6	5	4	4	4	3	3	3
50	---	9	7	6	5	4	4	3	3	3
60	---	9	7	6	6	5	5	4	4	4
70	---	10	8	7	6	6	5	5	4	4
80	---	---	8	7	7	6	5	5	5	4

1/2 inch pipe

Pressure at source in pounds per square inch	Length of pipe in feet									
	20	40	60	80	100	120	140	160	180	200
10	10	8	5	5	4	3	3	3	3	3
20	14	10	8	6	6	5	5	4	4	4
30	18	12	10	8	8	7	6	6	5	5
40	20	14	11	10	10	8	7	7	6	6
50	---	16	13	11	11	9	8	7	7	7
60	---	18	14	12	12	10	9	9	8	7
70	---	---	15	13	12	11	10	9	8	8
80	---	---	---	---	---	---	---	---	---	---

3/4 inch pipe

Pressure at source in pounds per square inch	Length of pipe in feet									
	20	40	60	80	100	120	140	160	180	200
10	22	14	12	10	8	8	7	6	6	6
20	30	22	18	14	12	12	11	10	10	8
30	38	26	22	18	16	14	13	12	12	10
40	---	30	24	21	19	17	16	16	15	13
50	---	34	28	24	21	19	18	17	16	15
60	---	38	31	26	23	21	20	19	18	17
70	---	---	34	29	25	23	22	21	19	18
80	---	---	36	30	27	24	23	22	21	20

1 inch pipe

Pressure at source in pounds per square inch	Length of pipe in feet									
	20	40	60	80	100	120	140	160	180	200
10	40	28	22	18	16	15	14	13	12	11
20	55	40	32	27	24	22	20	19	18	16
30	70	50	40	34	30	27	25	23	22	20
40	80	58	45	40	35	32	29	27	25	24
50	---	65	57	45	40	36	33	31	29	27
60	---	70	58	50	44	40	36	34	32	30
70	---	76	63	54	45	42	40	37	34	32
80	---	---	65	57	47	43	39	37	35	33

Fig 2-3. Capacities of galvanized pipe in gpm.

1-1/4 inch pipe

Pressure at source in pounds per square inch	Length of pipe in feet									
	20	40	60	80	100	120	140	160	180	200
10	80	55	45	37	35	30	27	25	26	24
20	110	80	65	55	50	45	41	38	36	34
30	---	100	80	70	60	56	51	47	45	42
40	---	---	95	80	72	65	60	56	52	50
50	---	---	107	92	82	74	68	63	60	55
60	---	---	---	102	90	81	75	70	65	62
70	---	---	---	---	97	88	82	74	69	67
80	---	---	---	---	105	95	87	79	74	72

1-1/2 inch pipe

Pressure at source in pounds per square inch	Length of pipe in feet									
	20	40	60	80	100	120	140	160	180	200
10	120	90	70	60	55	50	45	40	40	35
20	170	130	100	90	75	70	65	60	55	55
30	---	160	130	110	100	90	80	75	70	65
40	---	170	150	130	110	100	90	90	80	80
50	---	---	170	140	130	120	110	100	90	90
60	---	---	---	160	140	130	120	110	100	100
70	---	---	---	170	150	140	130	120	110	100
80	---	---	---	---	160	150	140	130	120	110

2 inch pipe

Pressure at source in pounds per square inch	Length of pipe in feet									
	20	40	60	80	100	120	140	160	180	200
10	240	160	130	110	100	90	90	80	80	70
20	300	240	200	160	150	140	130	120	110	100
30	---	300	240	200	180	160	150	145	140	130
40	---	---	280	240	220	200	180	160	160	150
50	---	---	---	280	240	220	200	200	180	160
60	---	---	---	---	280	240	220	200	200	180
70	---	---	---	---	300	260	240	220	220	200
80	---	---	---	---	---	280	260	240	220	220

Fig 2-3. Capacities of galvanized pipe in gpm -- con't.

Example: Using figures 2-1, 2-2, and 2-3 and the conditions given below, determine whether 1 1/4-inch galvanized pipe would be sufficient.

Given: Water pressure at the source is 60 pounds per square inch, and the length of the pipe run is 100 feet (30.5 meters). The plumbing system contains two urinals, one water closet, two lavatories, and two shower stalls.

Solution:

1. Use figure 2-1 to determine maximum figure demand as follows:

Number	Fixture	Fixture demand (gpm)		Total
2	Urinal	39 1/2 gpm	=	79 gpm
1	Water closet	45 gpm	=	45 gpm
2	Lavatory	7 1/2 gpm	=	15 gpm
2	Shower	15 gpm	=	30 gpm
		Total fixture demand	=	169 gpm

2. Determine the probable demand of water for the system using figure 2-2 as follows:

   (a) Enter figure 2-2 with the actual number of fixtures in the system to determine the factor of simultaneous use. The system that we are using as an example contains seven fixtures. Seven falls between 5 and 50, so you should choose 25-50 as the percent of simultaneous use from the figure. You should use 50 percent because when the number of fixtures in the system falls in the lower portion of the range in the Number of fixtures column of figure 2-2, you use the upper portion of the range in the corresponding Percent of simultaneous use column.

   (b) Multiply the total fixture demand by the factor of simultaneous use to determine the probable demand of the system.

   169 gpm x .50 = 84.5 gpm

3. Enter figure 2-3 at table for 1 1/4-inch pipe. Determine if the pipe is adequate for the system. The procedure you should follow to determine if 1 1/4-inch pipe is adequate for the system is as follows:

   (a) Locate table for 1 1/4-inch pipe in figure 2-3.

   (b) Enter the table at left side, at the 60 pounds per square inch row (the source water pressure in this problem) and read horizontally to the right to the 100 foot length of pipe column. You should find the number 90. This means that with a water pressure at the source of 60 pounds per square inch, a 1 1/4-inch pipe has a capacity of 90 gallons per minute over a pipe run of 100 feet.

You determined in steps 1 and 2 above that the sample system has a demand for water of 80.0 gallons per minute. Therefore, the 90 gpm capacity of 1 1/4-inch pipe indicates that the pipe is adequate for use in the system.

Fixture feed pipe is sometimes referred to as fixture supply riser. Fixture feed pipes are smaller diameter pipes that branch off the main supply line in the building to furnish water to the fixtures connected to that pipe. They are connected to the supply line by reducing tees and should have individual shut-off valves. The shut-off valves facilitate maintenance and do not affect other fixtures. These pipes are run through the interior walls of the building, so all joints must be leakproof.

Each individual fixture feed pipe must be large enough to supply water to all the fixtures to which it connects. The size of the fixture feed pipes can be determined by the same factors (pressure, total gpm, etc.) used to size water service lines.

Note: This study unit does not contain instructions on how to put together every part of a water supply, but instead deals with the principal parts of that supply. Some of these parts are the corporation stop (valve that taps into street main (fig 2-4)), the curb stop (shut-off valve usually at the curb of the street (fig 2-4)), and the meter stop (valve at the water meter just inside the building (fig 2-4)).

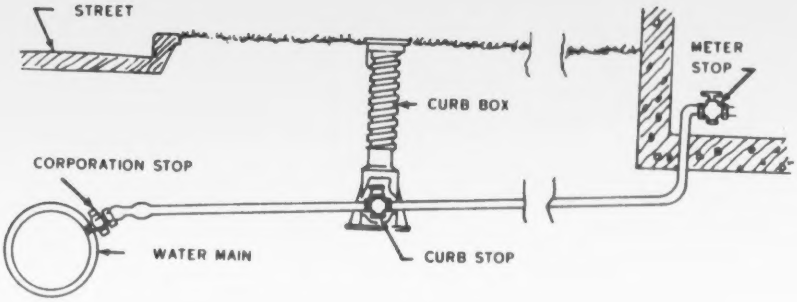


Fig 2-4. Water service from main into building.

Figure 2-4 shows a typical water service from the street main into the building, and figure 2-5 shows a typical main supply inside of the building.

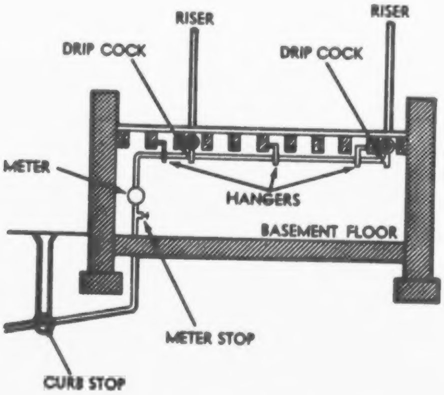


Fig 2-5. Typical main supply.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. What would be the size of the main line if the water service line is one inch in diameter?

   ____

2. The water service line must be of an adequate size to supply potable water to all the ____

3. Water pressure higher than 60 pounds per square inch in a water line can cause leaks and valve failures. What should be done if higher pressures are encountered?

   ____

   ____

4. Two of the most important factors to consider when sizing the water service line are the maximum fixture demand and the ____________________

5. The water service line taps into the ____________________

6. The main supply line is that part of the plumbing system which feeds the ________
____

7. To make it easier to work on individual fixtures, each fixture feed line should have ____

8. The same factors are used to determine the size of the fixture feed lines as you would use to determine the size of ________________________

Work Unit 2-2. PLUMBING FIXTURES

IDENTIFY THE SINGLE MOST IMPORTANT FACTOR IN THE INSTALLATION OF A WATER CLOSET.

IDENTIFY THREE TOOLS USED TO CLEAR OBSTRUCTIONS IN WATER CLOSETS.

STATE THE MOST IMPORTANT SINGLE FACTOR IN INSTALLING A URINAL.

STATE THE TWO MAJOR ITEMS IN THE MAINTENANCE OF URINALS.

IDENTIFY THE LEVEL AT WHICH A FAUCET SHOULD BE INSTALLED ABOVE THE OVERFLOW LEVEL.

IDENTIFY THE TYPES OF SHOWERS AND THE MOST IMPORTANT FACTOR IN THE INSTALLATION.

IDENTIFY THE MAJOR TYPES OF MAINTENANCE REQUIRED FOR SHOWERS.

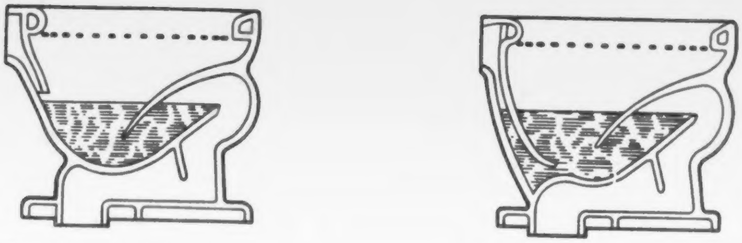
IDENTIFY THE TYPES AND MOST IMPORTANT FACTOR IN INSTALLING DRINKING FOUNTAINS.

IDENTIFY THE MAJOR TYPES OF MAINTENANCE REQUIRED FOR WATER FOUNTAINS.

Plumbing fixtures are the receptacles which receive wastes prior to discharge into the sewer. They are made of cast iron or steel covered with enamel and of vitreous china. They are usually installed in batteries in military installations.

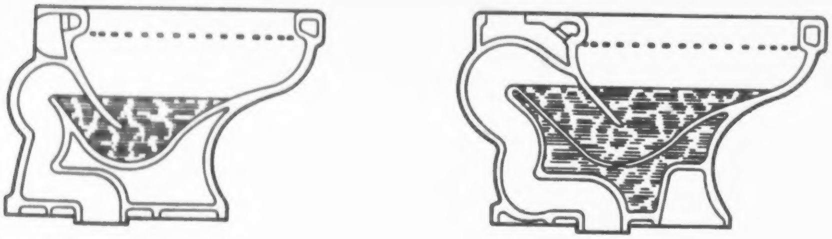
Water closets (fig 2-6) are available in a variety of types such as the common washdown bowl, the washdown bowl with jet, the reverse trap bowl, and the siphon jet bowl. All have an integral trap which creates a built-in seal and does not require a separate trap. Although these water closets are installed in the same way, they differ in their flushing action as explained below. Refer to figure 2-6.

- Washdown bowl. In this type, the trap is at the front of the bowl, and the flushing of the bowl is accomplished by small streams of water running down from the rim of the fixture.
- Washdown bowl with jet. This unit has a small hole in th bottom which delivers a direct jet or stream of water into the upper arm of the trap, starting a siphoning action immediately upon flushing of the unit.
- Reverse trap bowl. This trap is placed to the rear of the bowl, lengthening the fixture for better appearance. It holds more than the washdown bowl and is quieter in operation.
- Siphon jet bowl. This is the quietest and the most efficient type of water closet. It is similar in appearance to the reverse trap bowl, but maintains an almost full bowl of water.



① COMMON WASHDOWN BOWL

② WASHDOWN BOWL WITH JET



③ REVERSE TRAP BOWL

④ SIPHON JET BOWL

Fig 2-6. Types of water closets.

All floor-mounted water closets are installed (refer to fig 2-7) as follows:

- Slip the water closet flange over the closet bend or stab and slide it down until it is level with the floor.
- Make up the joint the same as any vertical caulked joint.
- With a hammer and chisel, break off the portion of the bend protruding above the closet flange. Care must be exercised at this point since the closet bend or stub may crack under the closet flange.
- Place two brass closet bolts in the flange slots.
- Turn the water closet upside down and place one roll of putty completely around the rim, and place a wax seal completely around the discharge opening or horn (fig 2-8). Do this carefully, as it will insure a watertight and gastight seal. This is the most important part of the installation.
- Install closet nuts on the closet bolts and tighten them. Alternate this tightening from one bolt to the other. The gasket seals the water closet on the closet flange. Do not overtighten or the water closet may crack.

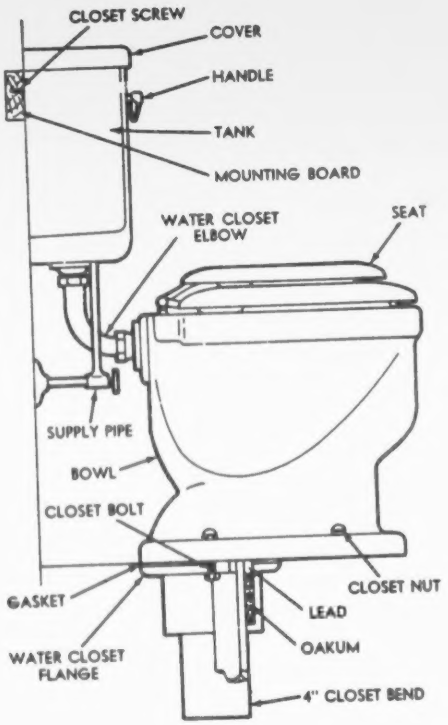


Fig 2-7. Detail of a water closet.

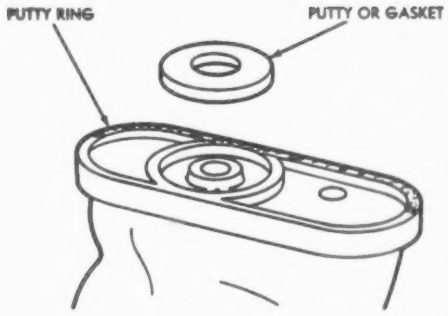


Fig 2-8. Placing putty on base of water closet.

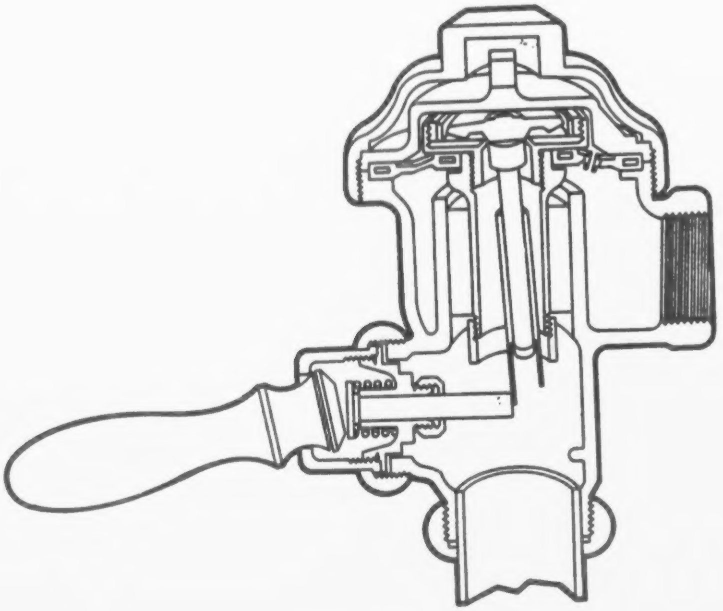


Fig 2-9. Diaphragm-type flushing valve.

In military installations, the water is usually supplied through a diaphragm-type flushing valve (fig 2-9). It gives a quick, automatic flushing action, and the amount of water delivered can be adjusted. This valve requires a 1-inch supply line, and it should be connected to a vacuum breaker to prevent back siphonage in the event of reduced pressure in the water pipe coinciding with a stoppage in the water closet.

The water supply or flushing action can also be supplied by a closet tank. This tank is set on the back of a two piece water closet, and the water is flushed into the bowl by tripping a lever (operating handle). Figure 2-10 shows the working parts of the closet tank.

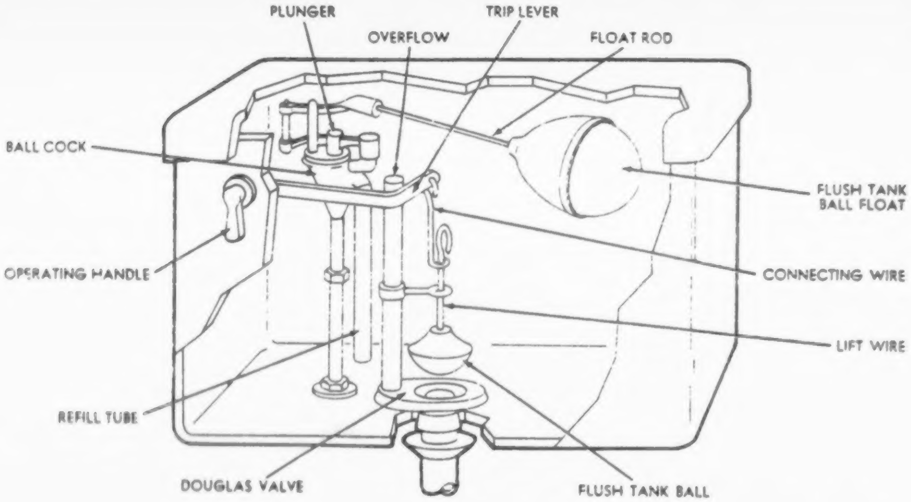


Fig 2-10. Closet tank working parts.

Water closets are designed to require little maintenance. They should need maintenance only when they are improperly used, such as flushing newspaper or trash in them or not flushing them at all. (Home and hotel water closets are most often stopped up by the flushing of sanitary napkins.) When a stoppage does occur, it usually can be cleared by the use of a plunger. Figure 2-11 shows a picture of a force cup plunger. To use it, simply place the force cup over the discharge opening at the bottom of the closet bowl, push down, and then pull up. (There should be water in the bowl so that a suction action can occur. If there is no water in the bowl, add some.)

Sometimes a stoppage may require more aggressive means. When this occurs, the closet auger is used (fig 2-12). To use this, place the bent end into the trap and then turn the handle, at the same time applying a down pressure. Figure 2-13 shows a closet auger inserted in a water closet.

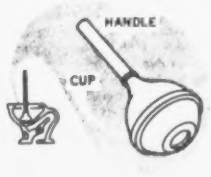


Fig 2-11. Force cup plunger.

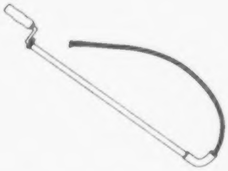


Fig 2-12. Closet auger.

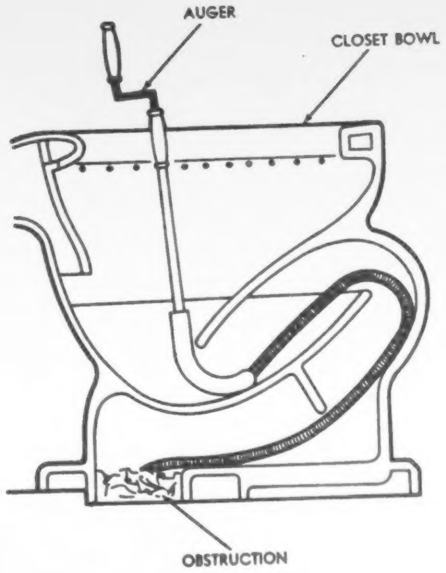


Fig 2-13. Detail of a water closet with auger inserted.

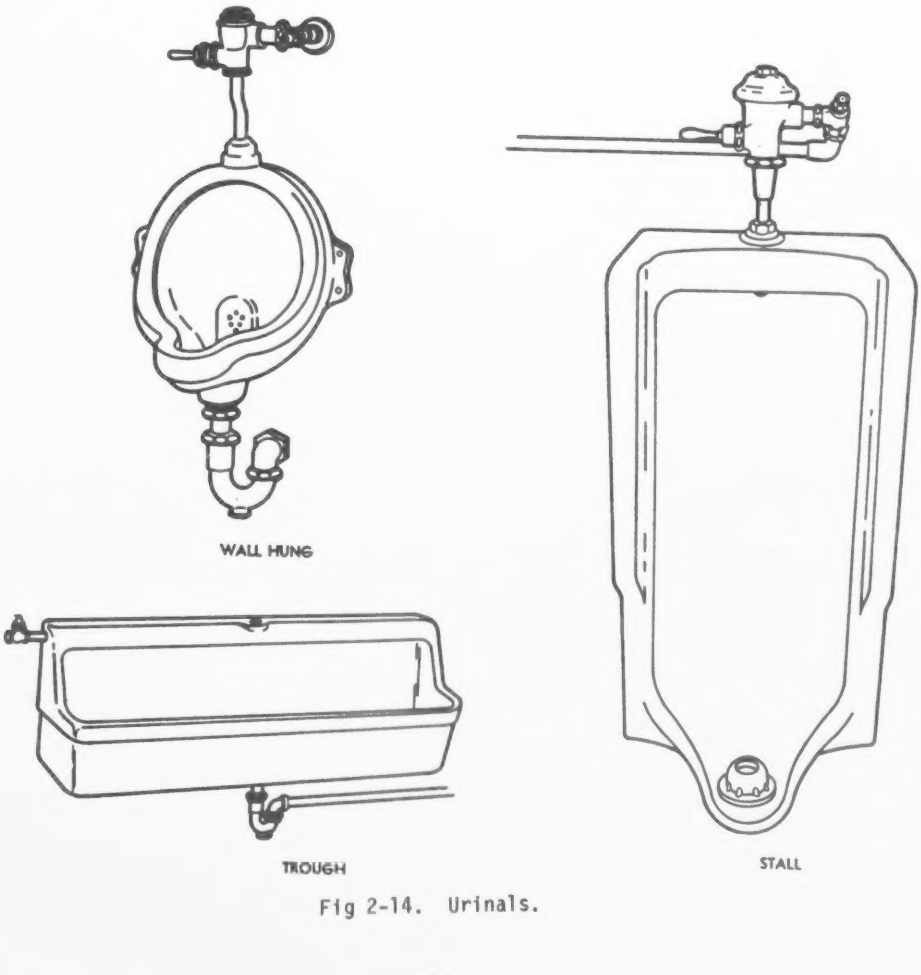


Fig 2-14. Urinals.

The two major types of urinals (fig 2-14) used in Marine installations are the wall hung and stall urinals. Most military installations utilize the wall hung type urinal. In older, outlying camps, another type of urinal, the trough, may be encountered.

- Wall hung. The operation of a wall hung urinal is similar to that of the water closet. Some types of wall hung urinals contain a trap that acts much like the one found in a water closet. (A trap is not needed for the wall urinal to operate.) The flushing action of the wall hung urinal (both with or without trap) is also similar to that of the water closet; it has a washdown or siphon jet action.

- Stall. The stall urinal is set into the floor and offers less chance of fouling the floor by carelessness. It has a washdown flushing action and an inner surface that is completely washed with each flushing action.

- Trough. This fixture is similar to an open sink and is hung from the wall by a hanger. The trough has perforated pipe across the top of the back which allows water to trickle down the back for flushing.

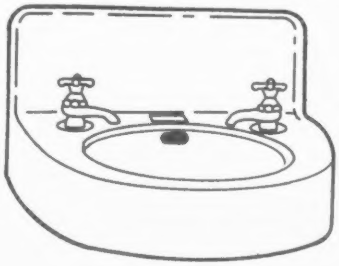
  Note: The trough urinal is the hardest to keep clean and the easiest to foul.

The lip of the wall hung or trough type urinal is placed about 20-25 inches (50.80-63.50 centimeters) from the floor to reduce fouling of the floor. Use a mounting board for wall hung and stall type urinals, and fasten them rigidly in place with brass bolts or screws. (Iron or steel bolts and screws corrode too easily for this application.) The spaces between the urinals should be sealed, if practical, with a moisture proof cement.

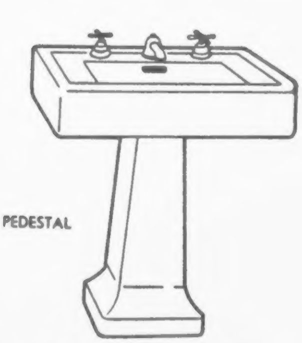
Note: A watertight seal should be obtained when installing all urinals.

Daily cleaning with a strong soap or disinfectant reduces the soil which fouls a urinal. Many foreign objects such as cigarette and cigar butts and chewing gun are dropped in urinals. Although the strainer catches most of this material, at times an article slips past the strainer into the trap. Such objects may clog the trap or waste line and cause the urinal to overflow. In this case, a force cup plunger should be used to remove the material. If the force cup falls to clear the stoppage, the trap may have to be disconnected. If the trap is part of the urinal, the trap may have to be dismounted to insert a snake into the waste line.

Lavatories and sinks are used for different purposes and, because of this, are designed differently. Lavatories and sinks come in assorted shapes for use on different types of jobs. A description of lavatories, sinks, and methods of installation and maintenance will be covered below.



WALL HUNG



PEDESTAL

Fig 2-15. Types of lavatories.

A wall-hung lavatory (fig 2-15) is a small basin usually made of vitreous china. It is placed in the bathroom and is used to wash the face and hands. A lavatory has its own feed line and has a drain which contains a trap. Figure 2-15 shows two types of lavatories: wall hung and pedestal. The following discussion will cover only the wall-hung lavatory, the type most often installed by the Marine plumber.

The wall-hung lavatory is suspended from a bracket screwed to the wall. It may or may not be additionally supported by legs. Figure 2-16 shows the roughed-in dimensions. In order to install a unit correctly perform the steps described below.

- Mark the wall at the correct height for the lavatory and secure the hanger to it.
- Position the lavatory on the hanger.
- Using a basin wrench (fig 2-17a), install the lavatory faucets (which are usually combination faucets).
- Install the pop-up drain as shown in figure 2-17b.
- Connect the tailpiece of the pop-up drain to the P-trap for drainage.
- Connect the water-supply lines. As you face the lavatory, the cold water should be on the right side and the hot water on the left side.

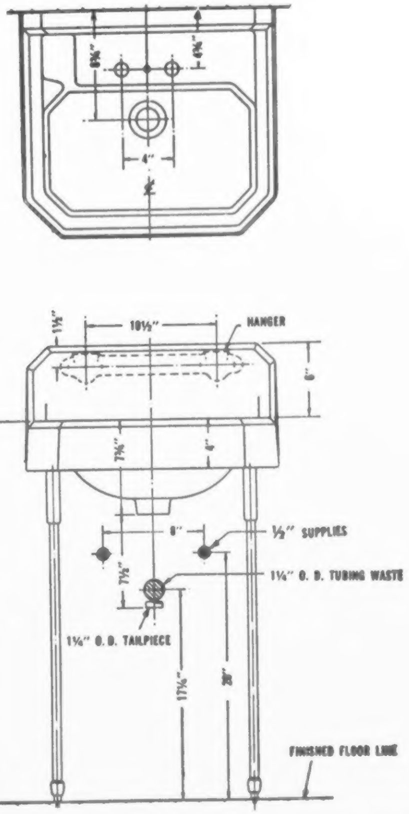


Fig 2-16. Roughing in measurements for a wall-hung lavatory.

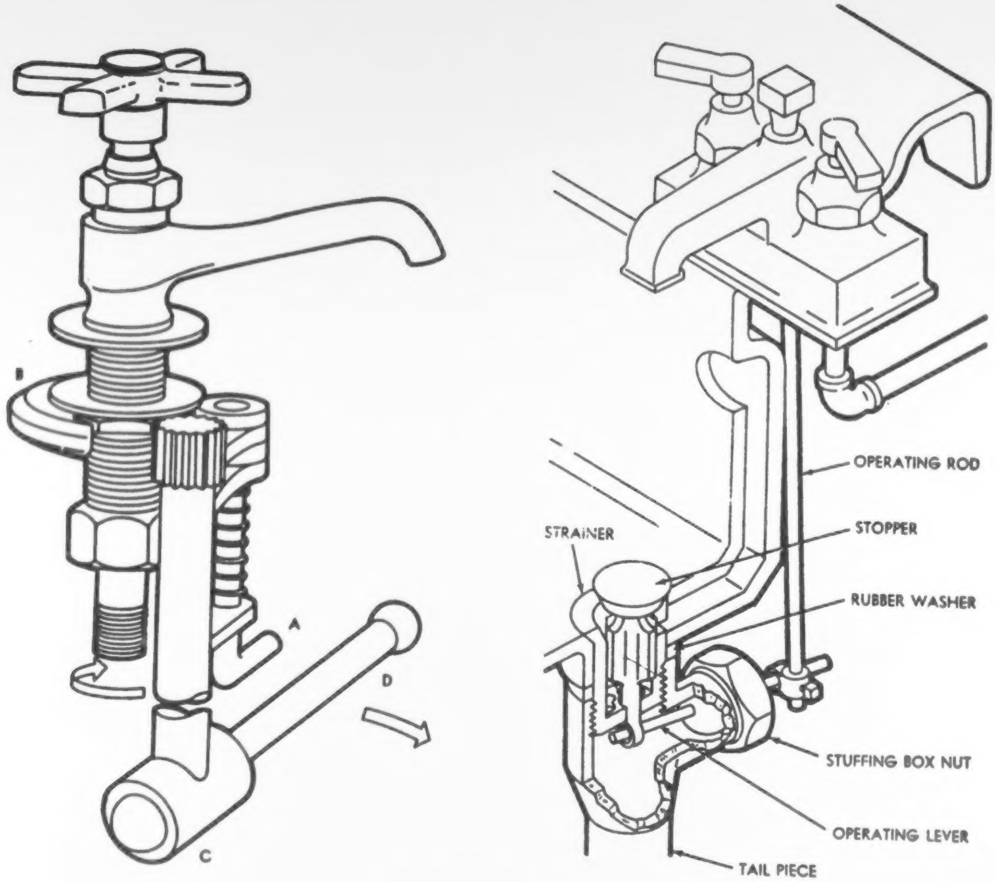


Fig 2-17. Basin wrench and pop-up drain.

Because foreign objects are sometimes washed into the drain, the lavatory may have to be upstopped. You do this by using the same procedure as with the water closet auger, but you use a sink snake. The sink snake has a handle for turning. You apply pressure to the snake as you turn the handle. This helps the snake go around the corners in the drain. It also allows the head of the snake to bore into the stoppage. By continuing to turn the handle in the same direction and pulling the snake out, the stoppage will be removed.

The faucets that are used in lavatories may develop leaks which may be caused by wornout seat washers (fig 2-18). To replace the seat washer, first turn off the water supply to the faucet and open the faucet all the way. With a monkey wrench, unscrew the packing nut. Turn the faucet handle to the left and remove the valve stem from the faucet body. Next, remove the small brass screw by which the washer is held in place at the end of the stem. Take off the old washer and insert a new one of the same size. Now place the screw through the hole in the washer and tighten it to the stem. Be sure the screw is tight; a loose faucet washer will cause a groaning or chattering noise every time the faucet is turned on. Replace the stem in the faucet and screw the packing nut back into position. If this faucet still leaks, it is probably the fault of the seat. Most faucets have replaceable seats. To remove them, an Allen wrench is inserted into the seat and turned out, and a new one put back in.

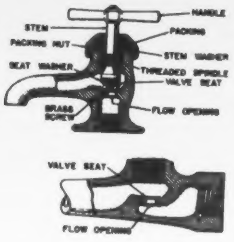


Fig 2-18. Cutaway view of a faucet.

Sinks differ from lavatories in both shape and use. Figure 2-19 shows some of the different types of sinks. Sinks can be made of vitreous china, stainless steel, or cast iron. Objects may be completely immersed within a sink. Clothes, vegetables, dishes, and pots and pans may be washed in a sink.

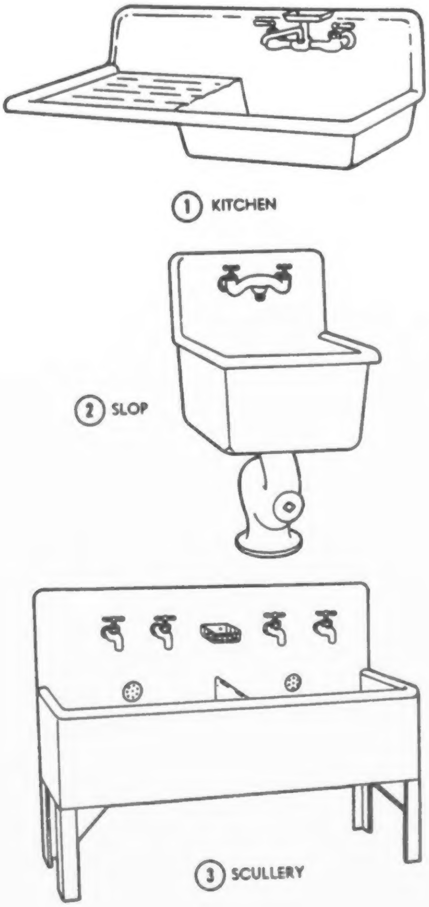


Fig 2-19. Types of sinks.

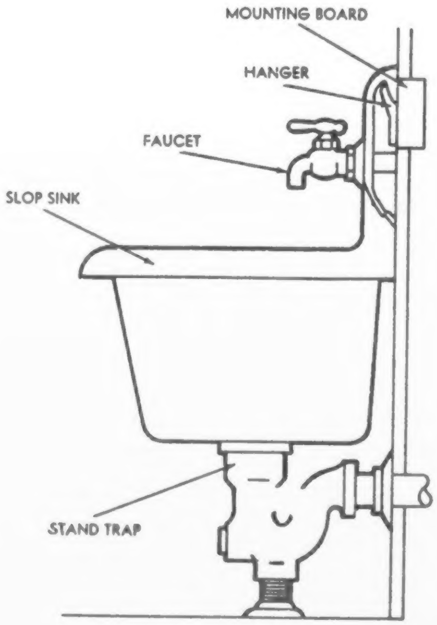


Fig 2-20. Slop sink installation.

The kitchen sink (refer to fig 2-19) can be mounted on a cabinet or on wall-mounted hangers. Faucets and drain and trap lines have to be connected to waste and water supply lines before the sink can be operated.

The slop sink (refer to figure 2-19) is also hung from a bracket and mounting board. In addition to the hanger, the slop sink (fig 2-20) has a built-in, adjustable stand trap which bolts to the floor and provides a pedestal support. The stand trap should be adjusted to take most of the weight off the hanger to keep the sink from sagging. The waste supply is then connected, and suitable faucets are installed and connected to the water supply.

Scullery sinks (refer to figure 2-19) need only installation of faucets and connections to waste and water-supply lines.

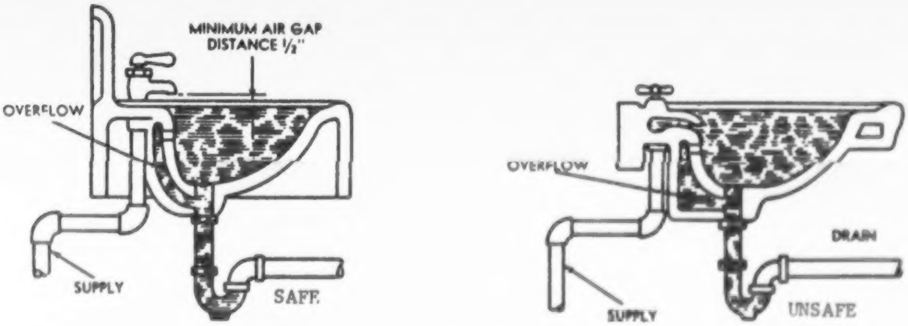


Fig 2-21. Air gap on lavatory.

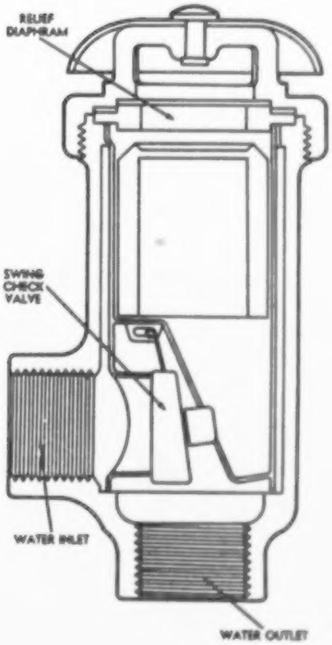


Fig 2-22. Siphon breaker.

A cross connection is a direct or indirect connection permitting waste sewage or undrinkable water to flow into a potable water supply. Direct connections consist of continuous connections leading nonpotable water into drinking water. Indirect connections consist of gaps or air spaces across which nonpotable water can be sucked or blown, contaminating the drinking water supply. There are many different types of cross connections, the most common being back siphonage of polluted water due to a submerged orifice (opening) on the water supply fixture; failure to maintain the correct air gap on faucets to a fixture; flexible hoses attached to water-supply pipes in the ground near sewer lines. Maintenance of the proper air gap on faucets supplying hot and cold water to fixtures is essential to prevent cross connections (fig 2-21). The faucet outlet should be 1/2 inch above the flood level of the rim of the fixture. This will insure that there is no danger of the waste water being sucked up into the potable water-supply line if the pressure in the water-supply line is reduced at the same time that the fixture is obstructed and floods to the rim. Any fixture which has a submerged orifice should not be installed unless it is equipped with a siphon breaker (fig 2-22). The siphon breaker, when mounted in the water-supply line, maintains a safeguard on the possibility of cross connection by preventing back siphonage. It contains a movable flap-type valve which closes if there is a pressure reduction on the inlet and prevents siphonage of water into the supply piping. Such a siphon breaker should be installed on all fixtures requiring a submerged flushing device under the flood rim on the fixture.

The maintenance of sinks is similar to that of lavatories in that the main concern is keeping foreign material out of the drain and clearing stoppages. The replacement of faucet washers is also necessary from time to time.

Showers are used in the military as the primary means for bathing. Showers use less water than bathtubs and require less floor space. They also cut down on bathing time.

The military generally uses two types of showers, the shower room and the individual stall. The shower room is usually quite large with tile or cement walls which can accommodate several persons at one time. The individual stall, which is used quite often now in the barracks, has three walls, a floor, and a curtain. The stall can be made of steel or plastic.

You must follow the manufacturer's instructions when you are installing an enclosed shower stall. The following is a discussion of general requirements for installation of showers used in the military. The most important requirement in a shower installation is the absolute waterproofing of walls and floors. Walls present less of a problem than floors since they are subject only to splashing of water and do not have water standing or collecting on them. Careful installation of the tile with good quality waterproof cement generally will provide a waterproof wall installation. In placing a tile floor, it is necessary to provide a waterproof subbase under the tile as standing water will gradually seep through the cement and cause leaks. To provide this, a lead shower pan must be installed (fig 2-25). Prior to installation, the general outline of the shower stall must be roughed in by the carpenter who must provide a solid base of subflooring or plywood on which the lead shower pan will rest. This wooden flooring is absolutely necessary as the lead shower pan is soft and pliable. If the pan is not supported properly, it may sag under the weight of the tile and may cause a leak. After the flooring has been checked for adequate support, inspect the rough-in of the trap underneath the flooring to see that the outlet is in the desired location. A variety of shower drains is available. The type shown in figure 2-25 has a nipple of the proper length to place the seepage flange of the shower drain at a level with the lead pan screwed into the trap. The flanged portion of the shower drain is screwed into the nipple. The lead pan is constructed by using a solid sheet of lead approximately 6 to 8 inches larger than the size of the shower floor and bending up the edges at angles to the desired height. A hole is cut in the location of the shower drain and the shower pan is lowered into place.

The shower pan should rest firmly on the seepage flange of the shower drain. Coat the inside of the shower pan with asphaltum. Paint the portion of the lead shower pan under the top of the flange with pipe joint compound and place a thin layer of putty on it. Place the upper flange on top of the lower flange and screw them together to form a watertight joint between the shower waste and the shower pan. Screw the strainer portion of the shower drain down into the flanges to the desired height of tiling. The installation is completed by laying cement in the shower pan and tiling the floor.

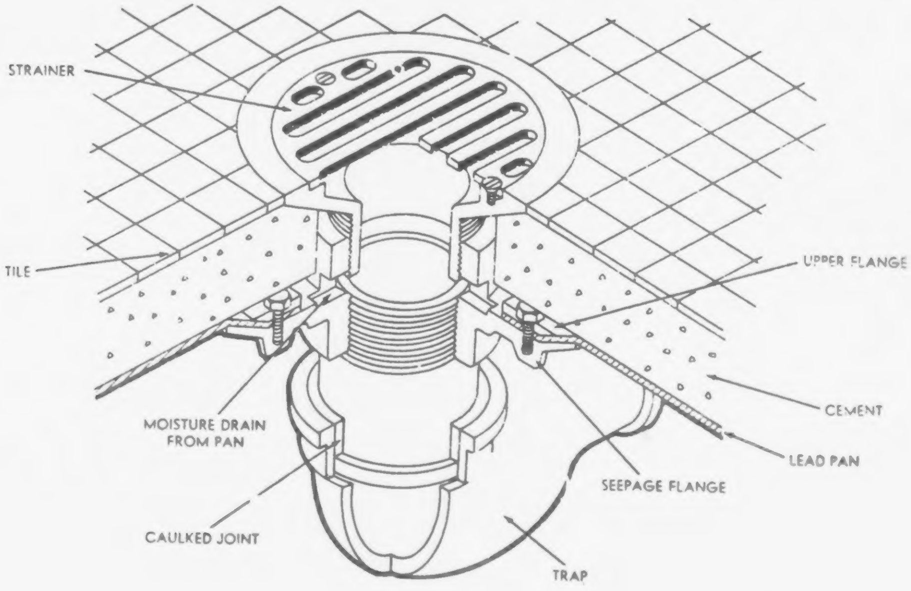


Fig 2-23. Shower pan.

The water supply for a shower installation may be concealed in the wall or may be exposed. Figure 2-24 shows hot- and cold-water lines tied into a single tempered water line terminating in a shower head. The cold-water line is brought in on the right-hand side, while the hot-water line is brought in on the left.

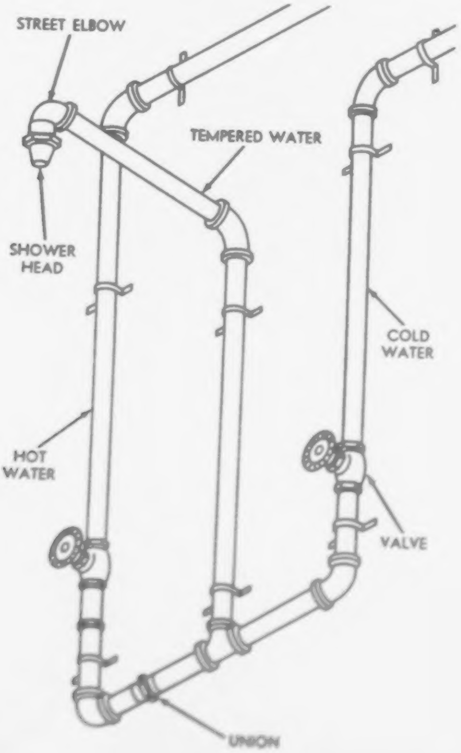
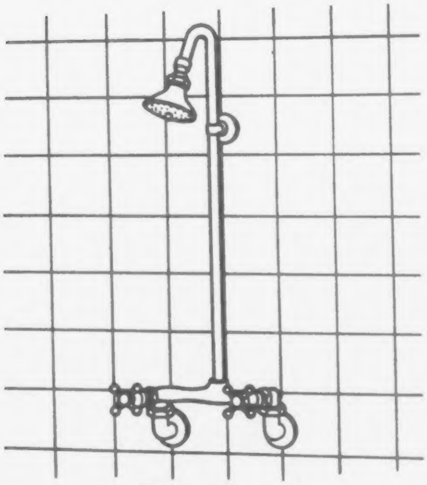
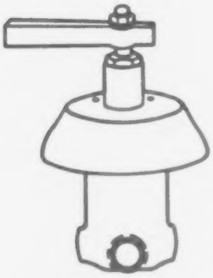


Fig 2-24. Exposed shower piping.

A number of faucet and valve combinations are available for the exposed installation (fig 2-25). The combination valve is a type of installation which provides a tempered water line of chromium plated tubing terminating in a gooseneck and shower head. In the chambered mixing valve, the hot and cold water is mixed in a cast brass mixing chamber. It has a sliding piston-like valve which is controlled by a single handle. By turning the valve handle clockwise, water of an increasingly warmer temperature is supplied to the shower head. There are more types of shower heads available than there are types of shower valves (fig 2-26). The choice of one type of shower head or another is generally a matter of personal preference.



① COMBINATION VALVE



② CHAMBERED MIXING VALVE

Fig 2-25. Types of valves.

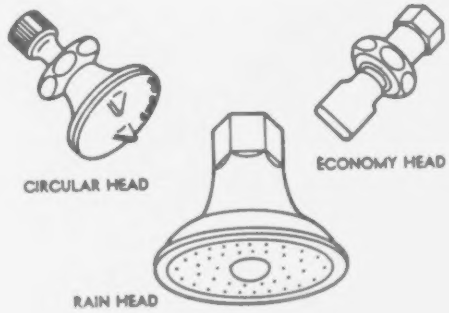
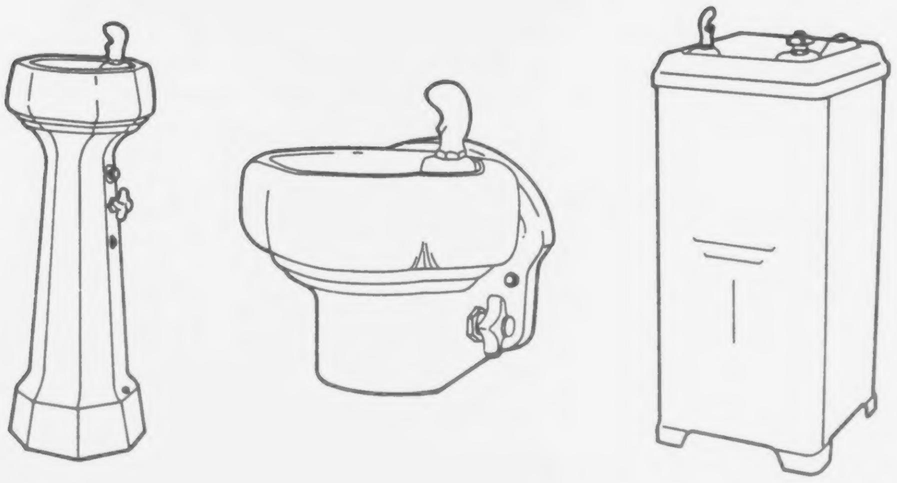


Fig 2-26. Shower heads.

The maintenance involved with showers is primarily concerned with keeping the drain clean and the clearing of stoppages. A stoppage in a shower caused by the accumulation of hair and scum in the trap or waste line may be cleared by removing the strainer and using a force cup or sink snake. Also, valve washers may have to be replaced periodically.

Drinking fountains (fig 2-27) are generally constructed of iron, stainless steel, or vitreous china and are made in three models--wall-hung, pedestal, and electrically cooled. The wall-hung fountain, as its name implies, is bolted to a mounting board on the wall. The pedestal fountain needs no wall support; it stands upon its pedestal. The electrically cooled fountain contains a refrigerating unit. Water is passed over the refrigerating coils and cooled before being supplied through the orifice. The most important factor to be considered in the selection of a drinking fountain is that of sanitation. The drinking fountain should be provided with a bubbler head so that the user cannot touch it. The water which he does not drink should not fall back upon the bubbler head.



PEDESTAL FOUNTAIN WALL FOUNTAIN ELECTRICALLY COOLED FOUNTAIN

Fig 2-27. Types of drinking fountains.

All types of drinking fountains should be installed with the orifice located at a suitable distance above the floor, depending upon the general height of the people who will be using it. The mounting of the fixture should be sturdy and capable of sustaining considerable weight in addition to that of the fixture. Most drinking fountains must be installed with a 1 1/4-inch P-trap underneath the waste, but a few are available with integral traps. The electrically cooled-drinking fountain requires an electrical outlet nearby for power.

The maintenance of drinking fountains generally is confined to keeping the drain clean and the clearance of stoppages with a force cup or sink snake. The height of the stream of water leaving the bubbler may have to be adjusted. This is done by turning a setscrew located between the water valve and the bubbler. The setscrews are not placed in any certain spot, so you will have to trace the line to locate them.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The siphon jet bowl type of water closet is the quietest and most efficient of all four types of water closets. One of the reasons is that it ____________________
   ____

2. A water closet is known in the plumbing trade as a (an) ____________________
   ____

3. A good watertight seal is the most important part of the water closet installation. During this installation you must be careful not to crack the bowl when ____
   ____

4. If a force cup plunger fails to clear a stoppage in a urinal, the next step would be to use a closet auger or a ____________________

5. What is needed to use the force cup plunger properly in clearing an obstruction in a water closet?
   ____

6. Which urinal is the easiest to foul and the hardest to keep clean?
   ____

7. List the two major types of urinals?

8. What type of urinal is flushed by water trickling down from a perforated pipe?

9. When installing a urinal, you should be sure to obtain a(an) ______________ seal.

10. List the two major items involved in the maintenance of a urinal?

11. Identify two types of lavatories?

12. The lavatory is a small basin that is primarily used to ________________________

13. What are two types of sinks?

14. A sink is primarily used to ____

15. Faucets should be installed a minimum distance of 1/2 inch above the overflow of a lavatory. What is this distance called?

16. A cross connection may allow sewage, waste, or other undesirable liquid to flow into the ____

17. One of the main objectives of sink maintenance is keeping foreign material out of the drain; another is ______________________________________

18. What are the two types of showers found in Marine installations?

19. When comparing the characteristics of a bathtub to those of a shower, a shower will

20. Waterproofing the shower floor is the most important requirement in an installation. This is accomplished by the installation of _______________

21. In the maintenance of showers the primary concerns are keeping the drains clean and

22. One of the barracks shower valves is leaking. What could be a cause of this leaking?

23. The wall hung and pedestal are two types of drinking fountains. What is another type?

24. One of the reasons why a drinking fountain bubbler head is protected is to _______

25. Sanitation should be your prime concern in the installation of a ________________

26. What does an electrically cooled drinking fountain require for operation?

____

27. One of the maintenance requirements of drinking fountains is the clearing of stoppages in the drain. Another maintenance requirement is keeping ______________

____

Work Unit 2-3. FIELD EXPEDIENTS

IDENTIFY THE TYPES OF FIELD EXPEDIENT HEADS AND THE MOST IMPORTANT FACTORS THAT SHOULD BE CONSIDERED WHEN INSTALLING THEM.

IDENTIFY THE METHODS OF SANITIZING A FIELD EXPEDIENT HEAD.

IDENTIFY THE TWO TYPES OF FIELD EXPEDIENT URINALS AND THE MOST IMPORTANT FACTOR IN THE INSTALLATION OF THEM.

IDENTIFY THE MAJOR TYPE OF MAINTENANCE REQUIRED FOR A FIELD EXPEDIENT URINAL.

In a combat zone or on field exercises, Marines do not have the sanitation facilities of garrison life. Until equipment and materials can come ashore, Marines have to devise temporary facilities to meet their needs. Field expedients are facilities which serve until something better is made. This work unit covers some field expedients for heads, urinals and showers.

When Marines are on the march, the only facility used is a "cat hole." This is a hole 1 foot deep (.30 meters) dug (and covered after use) by the person using it. If Marines will be staying in an area from 1 to 30 days, a straddle trench (fig 2-28) is used. For longer periods a pit type head (fig 2-29) is used. The pit type has a cover with seats. There are many ways to improvise head facilities. In areas where digging a pit is difficult, the drum type (burn out) head is used (fig 2-30).

An improperly placed expedient head facility can be a nuisance to the Marines in camp. It can cause a health hazard if placed too close to the unit's water supply. When at all possible, the head facility should be located downwind and downstream from the encampment and at least 100 feet (30.5 meters) from the nearest well or water source.

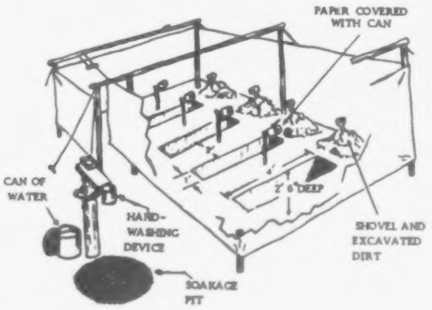


Fig 2-28. Straddle trench with hand-washing device.

A straddle trench (fig 2-28) is dug 1 foot wide, 2 1/2 feet deep, and 4 feet long (.30 meters wide, .76 meters deep, 1.22 meters long). This will accommodate two men at the same time. The number of trenches provided should be sufficient to serve at least 8 percent of the unit strength at one time. Thus for a unit of 100 men, at least 16 feet of trench or four 4-foot trenches are needed. The trenches should be at least 2 feet (.61 meters) apart. There are no seats in this type of latrine, but boards may be placed along both sides of the trenches to provide better footing. Some of the earth removed is piled at the end of each trench, and a shovel or paddle is provided so that each man can promptly cover his excreta.

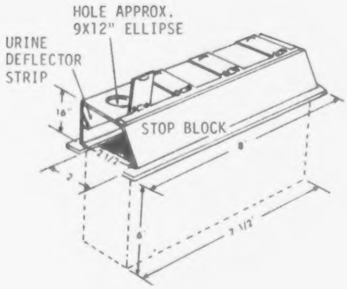


Fig 2-29. Deep pit head.

A deep pit head (fig 2-29) is a deep pit with a box placed over it. The standard box has four seats. It is 8 feet long and 2 1/2 feet wide at the base. A unit of 100 men requires two 4-seat boxes or 16 feet of space. The holes should be covered with flyproof, self-closing lids. Any cracks should be flyproofed by nailing strips of wood or tin over them. A metal deflector should be placed inside the front of the box to prevent urine from soaking into the wood. The deflector may be made from flattened cans.

The pit is dug 2 feet wide and 7 1/2 feet long. This allows 3 inches of earth surface on each side of the pit to support the box. The depth of the pit depends upon the estimated length of time the head is to be used. As a guide, a depth of 1 foot is allowed for each week of estimated use plus 1 foot of depth for dirt cover when it is to be closed. It is not generally desirable to dig the pit more than 6 feet deep because of the danger of the walls caving in. Rock or a high ground water level may also limit the depth of the pit. In some soils, supports of planking or other material may be necessary to prevent the walls from caving in. Earth should be packed tightly around the bottom edges of the box to seal any openings through which flies could gain entrance.

It is sometimes desirable to install a vent stack in the more permanent pit heads to release the moisture-laden gases of decomposition. This prevents condensation, which may come in contact with an individual's back, from forming on the inside of the self-closing lids. The vent stack should extend from the upper part of the pit to approximately 6 feet (1.83 meters) above the ground level. The outside opening of the vent stack must be screened.

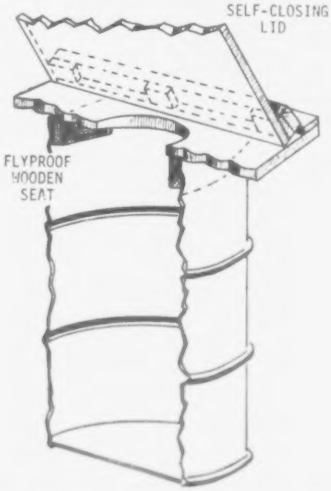


Fig 2-30. Drum (burn-out) head.

Drum (burn-out) heads (fig 2-30) may be provided when the soil conditions (hard, frozen, rocky) make digging a deep pit difficult. It is also particularly suitable for areas with high water tables. The burn-out head should not be used when air pollution regulations prohibit open fires. For a unit of 100 men, at least eight are needed. A 55-gallon (320 liter) drum is placed into the ground, leaving enough of the drum above the ground for a comfortable sitting height. The drum may be cut in half to make two latrines of lesser capacity. A wooden seat with a flyproof, self-closing lid should be placed on top of the drum. Personnel are encouraged to urinate in a urinal rather than the burn-out head as more fuel is required to burn out one containing liquid.

Keeping field expedient heads sanitized is an important and necessary job. Improper sanitation can be harmful to the health and morale of the Marines at the camp. The usual methods of sanitizing heads are with chemicals, by burning, or by backfilling. If the head is enclosed, all doors should be tight fitting to prevent flies from entering. All openings in the head enclosure should be screened, and the screening kept in good condition.

When using chemicals to reduce odor or the fly population, you should be very careful. DO NOT mix different chemicals together as they may produce a poisonous gas. In deep pit heads, the daily use of lime to cover the waste material helps neutralize the odor and prevents flies from multiplying. A fly spray or liquid can be used to help lessen the fly problem. The seat area should be scrubbed with a disinfectant periodically to keep it clean.

The drum head can be burned out daily by adding sufficient fuel to incinerate the fecal matter. Highly volatile fuel such as gasoline should not be used because of its explosive nature. A mixture of 1 quart of gasoline to 5 quarts of diesel fuel (1 liter of gasoline to 5 liters of diesel fuel) is effective, but still must be used with caution. If the drum must be moved to another site before it is burned out, handles should be welded to the drum to make it possible for two men to carry the drum with ease. It is convenient to have two sets of drums, one set for use while the other set is being burned clean. If the contents are not rendered dry and odorless by one burning, they should be burned again. Any remaining dry ash should be buried. Deep pit type heads can be burned out periodically, but care should be used not to set the wooden seats on fire.

Backfilling is probably the most effective way to reduce odor and fly problems. (Backfilling is putting back some or all of the earth that was taken out when digging the trench.) Each time the straddle trench is used, it is each Marine's responsibility to cover his own fecal matter. There should be a shovel and a mound of earth available so that this can be accomplished. When it is time to move out of the area, the trenches should be backfilled with earth, mounded 8-10 inches (20-25 centimeters) high on top of the trench.

Note: All completely backfilled heads should be marked with a closed-head sign. The sign should be dated so that if the area is inhabited in the future, the Marines involved with setting up camp will know where the old heads are located and their last date of use.

The deep pit head can be backfilled by periodically adding a few inches of earth. This head should be backfilled totally when the amount of waste in the pit gets to be about 4 feet (1.22 meters) deep. The same procedure as described above for straddle trenches should be used to close the head when moving to a new location.

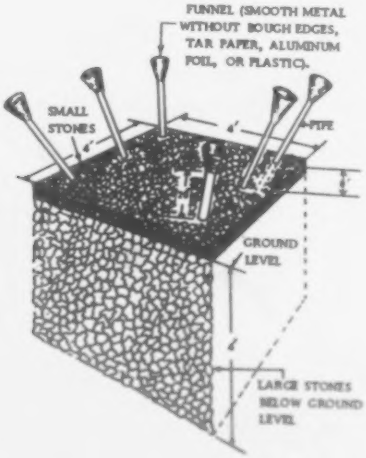

FUNNEL (SMOOTH METAL WITHOUT ROUGH EDGES, TAR PAPER, ALUMINUM FOIL, OR PLASTIC).
SMALL STONES
4'
4'
PIPE
GROUND LEVEL
4'
LARGE STONES BELOW GROUND LEVEL

Fig 2-31. Urinal pipes and soakage pit.

Urine disposal facilities should be provided to accommodate five out of 100 men at one time. Drainage is the most important consideration in urinal installations. Urinals should be drained either into a soakage pit or into a standard deep pit head if the urinals are constructed in conjunction with it. The urine may be drained into a deep pit through a pipe, a hose, or a screened trough. If a soakage pit is to be used, it should be dug 4 feet square and 4 feet deep (1.22 meters square and 1.22 meters deep) and filled with rocks, bricks, broken bottles, or similar rubble. It should then be covered with tar paper, boards, or other suitable material and a layer of earth. If the urine disposal facility is located some distance from the sleeping area, another urinal should be provided at a convenient location for use at night. In the following discussion, the pipe urinal (fig 2-31), the trough urinal (fig 2-32), and the oil urinal/urinoil (fig 2-32) will be covered.

Urinal pipes (fig 2-31) should be at least 1 inch (2.54 centimeters) in diameter and approximately 3 feet (.91 meters) long. They are placed at each corner of the soakage pit and, if needed, on two sides halfway between the corners. The pipes are inserted to a point 8 inches (20.32 centimeters) below the surface of the pit with the remaining 28 inches (71.12 centimeters) slanted outward above the surface.

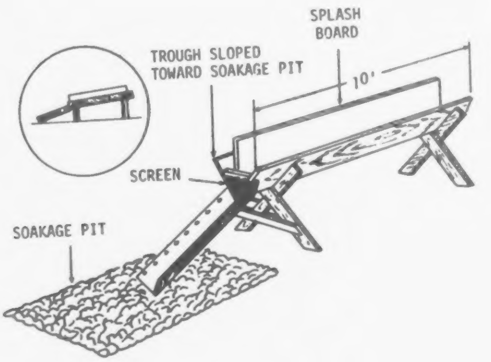


Fig 2-32. Urinal trough and soakage pit.

Urinal trough and soakage pit (fig 2-32) should be provided when the necessary materials are more readily available than pipes. This trough should be about 10 feet long (3.05 centimeters) and made of sheet metal or wood with eight V- or U-shaped ends. If the trough is made of wood, it should be lined with heavy tarpaper or metal. A splash board should be inserted down the middle of the trough. The legs which support the trough should be cut slightly shorter on one end. At this lower end a shallow trough or a pipe should be attached to carry the urine from the urinal trough to the soakage pit or deep pit head.

Oil urinal/urinoil (fig 2-33). In areas where the ground water level is not too high, that is more than 3 feet (.91 meters) below the surface, the urinoil is an acceptable substitute for other types of urine disposal facilities. The urinoil is a 55-gallon drum designed to receive and trap urine and to dispose of it into a soakage pit as illustrated in figure 2-33. Urine voided through the screen onto the surface of the waste oil immediately sinks through the oil to the bottom of the drum (because water is more dense than oil). As urine is added, the level rises within the 3-inch (7.62 centimeters) diameter pipe and overflows into the 1 1/2-inch (3.81 centimeters) diameter pipe through the notches cut in the top of this pipe. The oil acts as an effective seal against odors and against the entrance of flies. The screen on top of the oil is lifted by supporting hooks and cleaned of debris as necessary. Use 5 gallons (20 liters) of waste oil or fuel oil initially, and periodically add to that amount as needed.

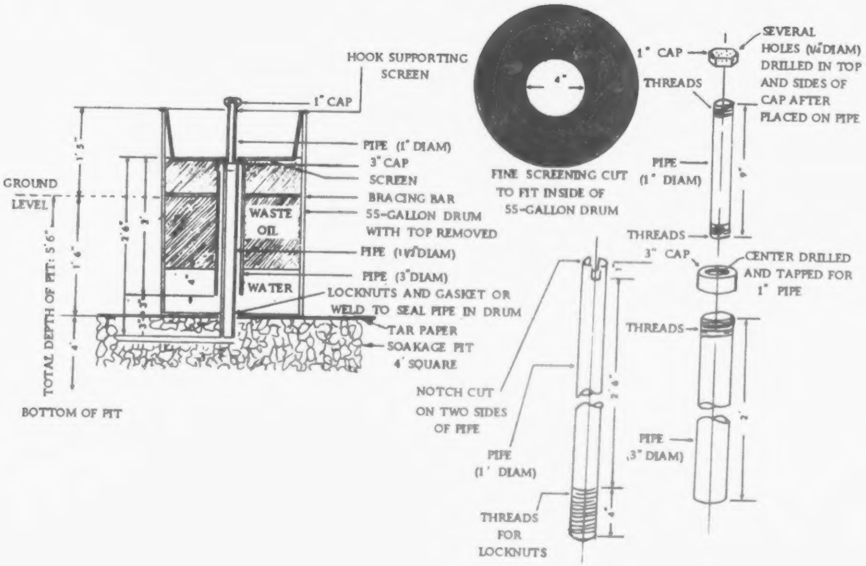


Fig 2-33. Urinoil.

In order for any type of urinal soakage pit to work properly, Marines must not urinate directly on the surface of the pit. The inlets and funnels should be cleaned and washed daily, and screens should be cleaned and replaced as needed. Such materials as oil and grease must never be poured into a pit because these products can slow (or stop) soakage of liquid into that area. If the amount of liquid in an oil urinal seems to be down, add some fuel oil or waste oil to the liquid. When the time comes to close down a urine soakage pit, the same procedure that is used for closing expedient heads should be followed.

Although showers are considered a luxury in the field, they should be provided whenever possible. Showers are important to the health and morale of Marines in the field. An expedient shower can be installed until a more permanent one is available.

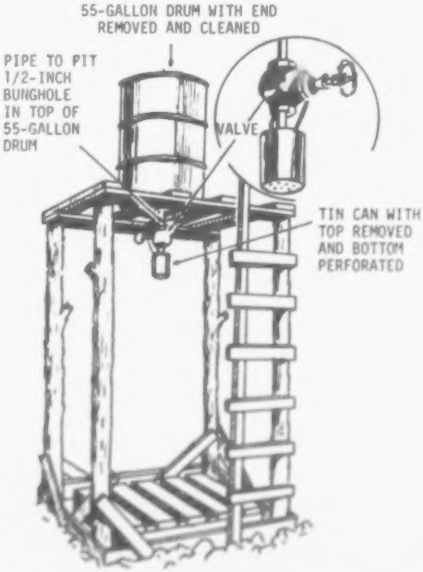

55-GALLON DRUM WITH END REMOVED AND CLEANED
PIPE TO FIT 1/2-INCH BUNGHOLE IN TOP OF 55-GALLON DRUM
VALVE
TIN CAN WITH TOP REMOVED AND BOTTOM PERFORATED

Fig 2-34. Expedient drum shower.

There are numerous ways or methods to improvise a shower. Usually one of the first items to be landed on the beach will be fuel drums. In this discussion a type of shower using an empty fuel drum will be dealt with. In some climates heat from the sun will take the chill out of shower water. Most improvised or expedient showers do not have any method of heating the water.

A 55-gallon (220 liter) drum can be converted into a suitable water container by removing the bottom and fitting the bunghole, on the top of the container, with a valve for the water outlet (fig 2-34). Be sure to clean the inside of the drum with soap and hot water prior to using. The drum is then placed upside down on an overhead platform and a perforated tin can shower head is fastened over the water outlet. The platform should have a suitable soakage pit under it with a wooden duckboard cover (fig 2-34).

The maintenance involved with most expedient type showers is keeping foreign material out of the shower water. Also, the duckboards should be scrubbed periodically with a disinfectant to kill fungus growth. The platform should be checked for any defects in construction.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The deep pit is one type of field expedient head. Another is the ________________

    ____

2. What are the dimensions of the deep pit expedient head?

    ____

3. What are the three factors to consider when installing a field expedient head?

    ____

    ____

4. What are the methods of sanitizing field expedient heads?

    ____

5. Which chemical can be used daily in field expedient heads to help with odor and fly problems?

    ____

6. Which procedure(s) is involved in closing a field expedient head?

    ____

7. Two types of field expedient urinals are the pipe urinal and the __________ urinal.

8. The operation of the urinoil or oil urinal is based on the fact that ______________

    ____

9. The most important factor in the installation of a field expedient urinal is _____

    ____

10. In a field expedient urinal, the area which the urine drains into is called a _____

    ____

11. What procedures should be followed when closing down a field expedient urinal?

    ____

12. What is the maintenance of field expedient urinals mainly concerned with?

    ____

13. There are many ways to improvise expedient showers. One type of field expedient shower is called a ______________________________

14. An important requirement for a field expedient shower is that ______________________________

Work Unit 2-4. TOOLS AND SAFETY PROCEDURES

IDENTIFY THE PROCEDURES USED IN THE CARE OF TOOLS.

IDENTIFY THE TWO SAFETY PROCEDURES INVOLVED WITH PLUMBING TOOLS.

IDENTIFY THE SAFETY PROCEDURES INVOLVED WITH PLUMBING MATERIALS.

Plumbing tools are very expensive; therefore, it is to the Marine plumber's advantage to care for the plumbing tools he uses. Improper use can damage tools and make them unsafe. Damaged tools can produce shoddy workmanship, which in turn increases the possibility of leaks in the installation. You should use tools only for the purposes for which they were designed. A screwdriver should be used to turn screws, not as a prybar or chisel. A wrench should be used to turn nuts or pipes, not as a hammer or prybar. If the wrench (pipe wrench) has gripping edges on the jaws, its intended purpose is to grip on smooth pipe and not to turn flat-sided nuts or soft metal such as brass or copper. Keep the gripping edges on the jaws clean by using a wire brush to remove the metal burrs that accumulate. A claw hammer is not intended to be used for hitting a chisel; use a ball peen hammer instead. If a hammer head is chipped or the handle is cracked or notched, you should have the tool replaced. A chisel should be sharp, and its head should not be mushroomed. A wood chisel should be used for wood only. Do not throw tools around or treat them carelessly. When you are finished with a tool, clean it properly and put it away where it belongs. If a metal tool is to be stored for a long period of time, it should be cleaned, and a light coat of oil or rust preventative should be applied. The tool should be stored in a suitable container that will keep out such substances as moisture and dust. Keep fragile tools away from bulky, heavy tools. The wood part of a tool should be kept clean and oil free. If there are cracks or splits in the wood, then these parts should be replaced if possible.

Remember, proper care of tools requires you to:

- Select the correct tool for the job.
- Use the tool properly (don't abuse).
- Keep the tool sharp if it has an edge.
- Repair or replace any defective parts of the tool.
- Keep the tool clean and free of rust.
- Store the tool properly.

It is your duty and responsibility as a Marine plumber to work carefully, both for your own safety and that of your co-workers. Working with unsafe or improper tools could prove a safety hazard for you or your co-workers.

- The proper selection and usage of tools are important safety precautions to follow. Select the propersize wrench for a particular job and use it correctly. Do not use a wrench that is smaller than needed for the job, and then use a cheater bar (fig 2-37) foradded leverage. This procedure could cause you to break the wrench or damagethe piece you're working on. Also you could injure your hand or another part of your body. Figure 2-37 shows you the right way to apply leverage to a wrench

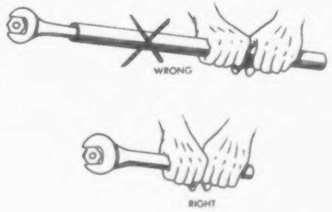
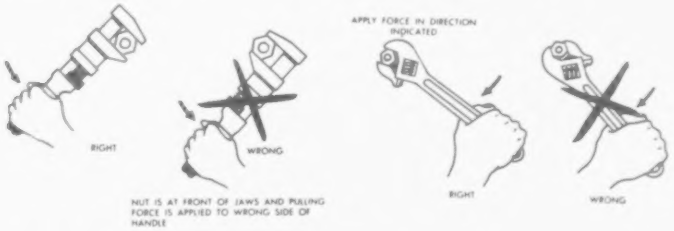


Fig 2-35. Applying leverage to a wrench.

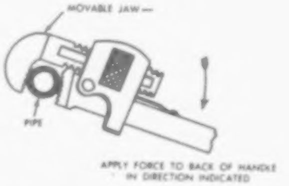
- Use a flat jawed type wrench on nuts and bolts. An adjustable wrench or monkey wrench is made for such items as flat surfaced nuts. Apply force in a correct direction as illustrated in figure 2-36.



RIGHT
WRONG
NUT IS AT FRONT OF JAWS AND PULLING FORCE IS APPLIED TO WRONG SIDE OF HANDLE
APPLY FORCE IN DIRECTION INDICATED
RIGHT
WRONG

Fig 2-36. Applying force.

- Pipe wrenches will work in one direction only. Figure 2-37 shows the correct way to apply force using a pipe wrench.



MOVABLE JAW
PIPE
APPLY FORCE TO BACK OF HANDLE IN DIRECTION INDICATED

Fig 2-37. Proper application of force with a pipe wrench.

- When working with chisels, insure that the cutting edge of the chisel is good. The strike portion of the chisel should not be mushroomed. A mushroomed chisel head could splinter off and cause an injury. Wear safety goggles and gloves when working with chisels or when sharpening them.
- Using a damaged hammer could cause a mishap. Make sure the head of the hammer has a good striking surface and the handle is in good shape.
- Do not carry edged or pointed tools in your pocket. If you have a screwdriver, open knife, or file in your pocket and happen to bend down or squat, you could get punctured by the tool.
- If an injury or mishap does occur, seek immediate medical attention. If this is not possible, follow first aid procedures found in the Marine Corps Essential Subjects handbook which all Marines should have.

The plumbing shop or work area can be hazardous if certain precautions and procedures are not followed. Remember, proper handling and usage of plumbing equipment and materials are essential to your safety and the safety of those around you.

- Develop a safe working attitude.

- Keep the work area clean and uncluttered. Keep materials such as oily rags in covered metal containers.

- Store flammable liquids in storage sheds or containers outside and away from the work area.

- When working with propane torches, blowtorches, or acetylene torches, follow instructions that guide you in lighting, operating, and shutting down that equipment. Use these torches in well ventilated areas. If in doubt about the way in which equipment should be used or whether an area has proper ventilation, ask your supervisor for help. Do not use this equipment alone unless you feel confident in handling it.

- Use protective equipment, such as eye goggles (fig 2-38), when using grinding machines, while soldering, or when striking chisels. Protective eye goggles should be worn whenever there is a slight possibility that a foreign object could enter the eye.

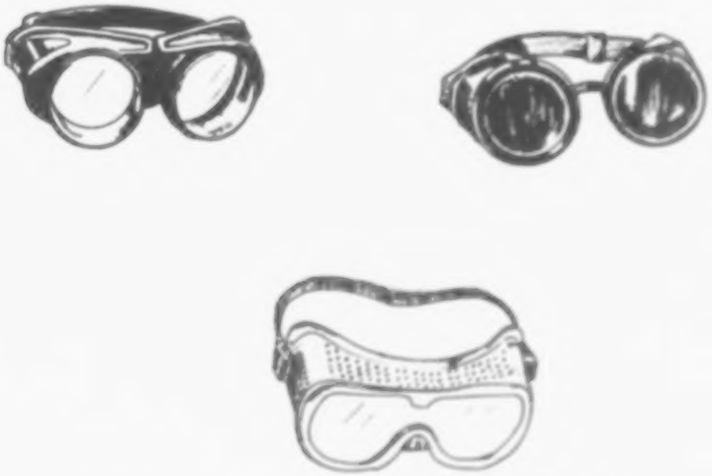


Fig 2-38. Some types of protective eye goggles.

- The use of protective gloves and footwear (safety shoes) is recommended when there is a danger of injury to your hands or feet. Remember, metal or plastic burrs can cut just like a knife.

- Do not burn plastic material because fumes from this type of material can emit a poisonous gas.

- Do not mix chemicals or get them wet.

- When heating lead, be sure that moisture or water does not mix with that material. If water and lead mix, the hot lead could splatter and possibly cause serious injury.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. Selecting the proper tool for the job, using the tool correctly, and keeping the tools sharp are some of the proper procedures for the care of tools. Which of the following are also proper procedures for the care of tools?

2. One of the Marine plumber's duties is to ______________________________

____

3. What are two safety procedures involved in working with plumbing tools?

____

____

4. When working with a chisel, it is a safety requirement that the cutting edge of the chisel be good and that ______________________________

5. When dealing with plumbing equipment and materials, you should insure proper handling and ______________________________

SUMMARY REVIEW

In this study unit, you have learned the water service provided in garrison and the field, including the associated fixtures. In addition you learned the types of tools required and the safety procedures required in their use.

Answers to Study Unit #2 Exercises

Work Unit 2-1.

1. One inch
2. fixture feed pipe.
3. Install a pressure reducing valve
4. factor of simultaneous use.
5. street main.
6. fixture feed line.
7. its own shut-off valve.
8. the water service line.

Work Unit 2-2.

1. maintains an almost full bowl of water.
2. fixture.
3. tightening the closet nuts.
4. snake.
5. Water in the bowl
6. Trough
7. Wall hung; Stall
8. Trough
9. watertight
10. keeping it clean and clearing stoppages
11. Wall hung; Pedestal
12. wash the hands and face.
13. Kitchen; Slop
14. immerse things.
15. Air gap
16. potable water line.
17. clearing stoppages.
18. Room; Enclosed stall
19. use less water.
20. a lead floor pan.
21. the clearing of stoppages.
22. Faulty valve washer
23. Electrically cooled
24. keep the user from touching it.
25. drinking fountain.
26. An electrical outlet nearby
27. the drain clean.

Work Unit 2-3.

1. drum.
2. 2-1/2 feet wide, 8 feet long
3. Downstream, downwind, 100 feet from water source
4. Burning, chemicals, backfilling
5. Lime
6. Mark the site and date it.
7. oil
8. water is more dense than oil.
9. drainage.
10. soakage pit.
11. Mark the site and date it.
12. Inlets cleaned, screens cleared, oil added
13. drum.
14. a soakage pit be installed.

Work Unit 2-4.

1. Cleaning and rust prevention
2. properly care for his tools.
3. Proper selection, proper usage
4. the head of the chisel not be mushroomed.
5. proper usage.

STUDY UNIT 3

STUDY UNIT OBJECTIVE: WITHOUT THE AID OF REFERENCES, YOU WILL IDENTIFY THE INSTALLATION AND MAINTENANCE ASSOCIATED WITH A PERMANENT SEWAGE SYSTEM, PLUS THE ASSOCIATED COMPONENTS THAT MAKEUP THE SYSTEM. IN ADDITION YOU WILL IDENTIFY SEVERAL TYPES OF FIELD EXPEDIENT SEWAGE SYSTEMS.

Proper sewage disposal is important to the health and welfare of all personnel. Sewage is the waste material that flows towards through a sewage system. It consists mainly of waterborne waste matter discharged from water closets, showers, and the kitchen or mess hall. It may also contain laundry wastes and other floating solids such as paper and grease. Sewage also contains large amounts of bacteria, most of which are harmless. Sewage may be dangerous if it contains harmful bacteria discharged by persons with infectious disease. Sewage is collected and treated primarily to prevent the growth and spread of communicable disease, but also to prevent contamination of water supplies and conditions that would be offensive to sight or smell. In this study unit, building sewers and drains, stacks, branches, vents, septic tanks, leaching fields, and grease traps associated with a permanent sewage system will be discussed. Also included will be the coverage of several types of field expedient sewage systems.

Work Unit 3-1. BUILDING WASTE SYSTEMS

IDENTIFY BUILDING SEWERS AND DRAINS IN THE SYSTEM.

IDENTIFY THE PROPER SLOPE TO BE MAINTAINED IN THE INSTALLATION OF A BUILDING DRAIN.

IDENTIFY THE PROPER SLOPE REQUIRED FOR A BUILDING SEWER LINE.

IDENTIFY THE MINIMUM SIZE OF A BUILDING DRAIN AND SEWER LINE IN A SEWAGE SYSTEM.

IDENTIFY THE MAJOR MAINTENANCE REQUIRED FOR DRAINS.

IDENTIFY THE STACK IN A SEWAGE SYSTEM AND HOW TO INSTALL IT.

IDENTIFY THE PURPOSE OF A VENT IN A SEWAGE SYSTEM.

IDENTIFY THE PROPER DIAMETER OF A VENT PIPE FOR A SEWAGE SYSTEM.

IDENTIFY THE MAJOR MAINTENANCE REQUIRED FOR VENTS.

IDENTIFY HOW THE COMPOSITION OF WASTE IS CHANGED IN A SEPTIC TANK.

IDENTIFY WHERE A SEPTIC TANK SHOULD BE INSTALLED AND THE MAINTENANCE REQUIRED.

IDENTIFY THE PURPOSE OF LEACHING FIELDS.

IDENTIFY THE MAIN FACTOR TO BE CONSIDERED IN THE LOCATION OF LEACHING FIELDS AND THE MAINTENANCE REQUIRED.

IDENTIFY THE PURPOSE OF A GREASE TRAP.

IDENTIFY THE PROPER LOCATION OF A GREASE TRAP IN A SEWAGE SYSTEM AND THE MAINTENANCE INVOLVED.

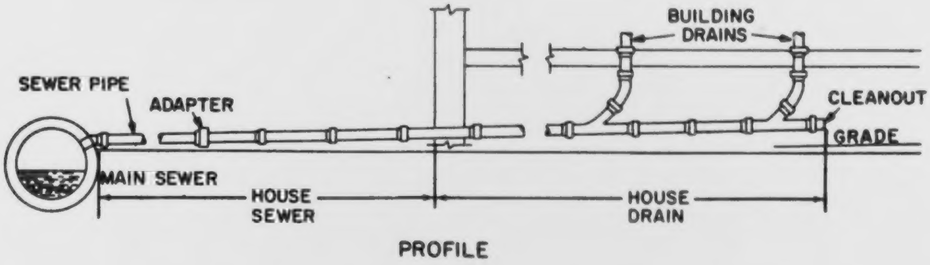


Fig 3-1. Building sewers and drains.

The sewer system is the pipes and apparatus which carry sewage from buildings to the point of discharge or disposal. It includes the sewer pipe or conduits, manholes, flush tanks, and sometimes storm-drain inlets. If it is not served by a processing plant, the system may include facilities for pumping, treatment, and final disposal of sewage.

There are two different types of sewage systems: storm sewers and sanitary sewers. A storm sewer carries only rain water, subsurface water, or similar wastes. A sanitary sewer carries liquid or waterborne waste from plumbing fixtures to the house sewer and then to the main sewer lines. Sanitary sewers are usually not connected to the storm sewers because the discharge from sanitary sewers MUST BE TREATED before it is pumped into a stream or lake. Since the discharge from storm sewers is merely runoff water, treatment is not needed. However, the two types of systems are sometimes combined into one system.

There are four basic parts of a waste system which are as follows: (1) the house sewer; (fig 3-1) which begins just outside the foundation and ends at a street sewer or a septic tank; (2) The house drain (fig 3-1) which receives the discharge of soil and waste within the building. It can be installed underground or suspended from the first floor joists. It is also called the "collection lines" and includes such appliances as house traps, backflow valves, cleanouts, and area drains. House drains will fall into one of four classes on any specific set of building plans.

- Combination system - This system receives the discharge of the sanitary waste plus the storm water from the roof and other exterior sources.
- Sanitary drain - This receives the discharge of sanitary and domestic waste only.
- Storm drain - This drain receives storm, clear water, or surface-water wastes only.
- Industrial drain - This type of drain system receives liquid wastes from industrial operations and is of little importance in theater of operations construction.

The part of the plumbing system that receives the discharge of water closets and carries this water to the house drain is called the soil pipe. The part of the drainage system that carries the discharge of sinks, lavatories, urinals, bathtubs, and similar fixtures is called the waste pipe.

Sanitary drainage systems are constructed of various types of pipes and fittings. Cast iron and galvanized steel are the pipe materials most often used. However, materials that may be permitted will depend upon the location where installed; for instance, aboveground within buildings, underground within buildings, or underground outside of buildings.

Aboveground piping within buildings consists of one, or a combination, of the following: brass or copper pipe, copper tubing, extra heavy or service weight cast iron, gaslvanized wrough iron, galvanized steel or lead. In case of single- or two-family dwellings, plastic pipe is acceptable for aboveground use.

Underground piping within buildings should be of cast iron. Service weight is used for buildings four stories and under and extra heavy weight is required for buildings over four stories. Proper authority, however, may permit the use of other piping, such as galvanized steel, lead, and copper. Where threaded joints are used underground, they should be coal tar coated and wrapped when installed.

Underground piping outside of buildings should be installed in a separate trench from the water-service pipe. The following materials may be used: vitrified clay, cast iron, plastic, concrete, asbestos cement, or bituminized fiber. The underground and the building drain or building sewer should not be less than 6 feet apart horizontally and should be separated by undisturbed or compacted earth. Where separate systems of sanitary drainage and storm building drains are installed, they may be laid side by side in one trench. A building sewer or building drain installed in fill or unstable ground should be of cast-iron pipe, except that nonmetallic drains may be used if laid on an approved continuous supporting system. Existing building sewers and drains may be used in connection with new buildings, sewer and drainage systems, only if they meet the requirements of the new systems. All joints should be watertight to prevent leakage of sewer water into the ground and infiltration of subsurface water into the sewer system. Special attention should be given the joints to prevent roots from growing into the sewer piping. The depth of the piping should be sufficient to protect the sewer from freezing. In addition, the lines must be protected from traffic. It may be necessary to provide special protection, such as encasing the piping in concrete, where the traffic loads are heavy.

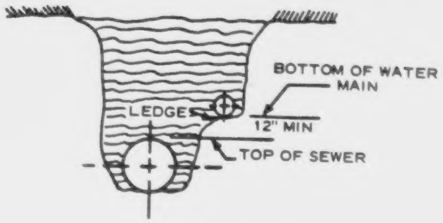


Fig 3-2. Building sewer and water-service line in the same trench.

It may be necessary, at times, to install the building sewer and the water-service pipe in the same trench (refer to fig 3-2). If so, make sure the following precautions are observed:

- See that the bottom of the water pipe is at least 12 inches above the top of the building sewer.
- Place the water pipe on a solid shelf at the side of the trench.
- Use hot-poured lead in making joints in cast-iron pipe for the building sewer; use a hot-poured compound in joining bell-and-spigot clay or concrete sewer pipe.
- After installation, test the building sewer with not less than a 10-foot head of water, or an equivalent test.

As was stated previously, the house or building sewer (refer to fig 3-1) is that part of the sanitary system beginning just outside the building foundation wall and ending at the main sewer in the street or at the septic tank. The house or building drain (refer to fig 3-1) is that part of the plumbing system which receives the discharge of all soil and waste stacks in the building and conveys it to the building sewer. To insure proper drainage of these two systems, you should know how to determine the proper size of the pipeline and how to install and grade it.

Horizontal piping in the sanitary drainage system should be installed at a uniform slope. This slope, pitch, grade, or drop per foot will determine the flow velocity of the liquid within the pipe. Piping of 3 inches or less in diameter requires a slope of not less than 1/4 inch per foot. In house or building plumbing, pipe larger than 3 inches in diameter requires a slope of not less than 1/8 inch per foot. This allows a velocity of not less than 2 feet per second, which will provide the scouring action necessary to maintain a pipe free from fouling. Sewer mains may have slopes of less than 1/8 inch per foot, providing that a cleaning velocity of 2 feet per second or greater is obtained (refer to table 3-1). Higher velocities, or greater drop per foot, will increase the carrying capacity of a drain. Keep in mind that a slope/drop of more than 1/4 inch per foot may cause siphonage of the trap seal.

The building drain in a sanitary system must be of sufficient size to carry off all the water and waste materials which may be discharged into it at any one time. The minimum allowable size is 3 inches for cast-iron pipe, but sound practice prescribes a 4-inch pipe, and most plumbing codes or ordinances require 4-inch pipe as a minimum. Increasing the size beyond that computed as required (the minimum of 3 inches still applies) does not increase the efficiency of the drain. The passage of liquid and soild waste through a horizontal pipe creates a natural scouring action, which is partially lost when the size of the drain is increased above the necessary size. The flow in too large a pipe is shallow and slow, and solids tend to settle to the bottom. The solids may accumulate to such an extent that they cause stoppages in the line. The optimum size of pipe should flow half full under normal use. This will create an efficient natural scouring action and still allow capacity for peak loads.

Table 3-1. Approximate Discharge Rates and Velocites in Sloping Drains

Flowing half full[1]

Discharge Rate and Velocity[2]

Actual inside diameter of pipe (inches)	1/16 in./ft slope		1/8 in./ft slope		1/4 in./ft slope		1/2 in./ft slope	
	discharge gpm[3]	Velocity fps[4]	discharge gpm	Velocity fps	discharge gpm	Velocity fps	discharge gpm	Velocity fps
1-1/4							3.40	1.78
1-3/8							4.44	1.90
1-1/2					3.13	1.34	5.53	2.01
1-5/8					4.81	1.50	6.80	2.12
2					8.42	1.72	11.9	2.43
2-1/2			10.8	1.41	15.3	1.99	21.6	2.82
3			17.6	1.59	24.8	2.25	35.1	3.19
4	26.7	1.36	37.8	1.93	53.4	2.73	75.5	3.86
5	48.3	1.58	68.3	2.23	96.6	3.16	137.0	4.47
6	78.5	1.78	111.0	2.52	157.0	3.57	222.0	5.04
8	170.0	2.17	240.0	3.07	340.0	4.34	480.0	6.13
10	308.0	2.52	436.0	3.56	616.0	5.04	872.0	7.12
12	500.0	2.83	707.0	4.01	999.0	5.67	1413.0	8.02

[1] Half full means filled to a depth equal to one-half of the inside diameter.

[2] Computed from the Manning Formula for 1/2-full pipe, n = 0.015

For 1/4 full: multiply discahrge by .274
multiply velocity by .701

For 3/4 full: multiply discharge by 1.82
multiply velocity by 1.13

For full: multiply discharge by 2.00
multiply velocity by 1.00

For smoother pipe: multiply discharge and velocity by 0.015 and divide by "n" value of smoother pipe

[3] Gallons per minute.

[4] Feet per second.

The standard method used in determining the size of a building drain is the Fixture Unit System. Drainage fixture unit (d.f.u.) valves for standard plumbing fixtures have been established. The Fixture Unit corresponds to 7-1/2 gallons or 1 cubic foot of water that an ordinary lavatory would discharge into the stack in an interval of 1 minute. All other fixtures commonly used in plumbing installation have been tested for maximum flow, and the fixture unit valves have been established for each and some of the most common are shown in table 3-2. Use the trap size listing at the bottom of table 3-2 for estimating d.f.u. valves for fixtures not listed.

Example:

(1) Assume that a plumbing installation consists of 25 water closets, 22 lavatories with 1 1/4-inch traps; 15 shower heads in group showers; 20 wall urinals; 2 service sinks with standard traps; and 4 floor drains (2 in). The total discharge, expressed in drainage fixture units, would be calculated as follows from table 3-2:

Number	Fixture	Unit value		Total
25	Water closet (flush valve)	6	=	150
22	Lavatories (1 1/4)	1	=	22
15	Shower heads	2	=	30
20	Urinal (wall)	5	=	100
2	Sinks (service)	3	=	6
4	Floor drain	1	=	4
	Total fixture units			312

After calculating the total discharge and determining the slope of the piping and the velocity of flow, the correct size of pipe is selected by using table 3-3.

Table 3-2. Drainage fixture unit valves for various plumbing fixtures

Type of fixture or group of fixtures	Drainage fixture unit values
Automatic clothes washer (2" standoff)	3
Bathroom group consisting of a water closet, lavatory and bathtub or shower stall:	
Flushometer valve closet	8
Tank type closet	6
Bathtub (with or without overhead shower) 1-1/2" trap	2
Bibet 1-1/2' trap	3
Clinic sink	6
Combination sink-and tray with food waste grinder 1-1/2" trap	4
Combination sink-and-tray with one 1-1/2 trap	2
Combination sink-and-tray with separate 1-1/2" trap	3
Dental unit or cuspidor	1
Dental lavatory	1
Drinking fountain	1/2
Dishwasher, domestic	2
Floor drains with 2" waste	3
Kitchen sink, domestic, with one 1-1/2" trap	2
Kitchen sink, domestic, with food waste grinder	2
Lavatory with 1-1/4" waste	1
Laundry tray (1 or 2 compartments)	2
Shower stall, domestic 2" trap	2
Sinks:	
Surgeon's	3
Flushing rim (with valve)	6
Service (trap standard)	3
Service (P trap)	2
Pot, scullery, etc.	4
Urinal, pedestal, syphon jet blowout	6
Urinal, stall lip	4
Urinal Stall, washout	4
Urinal trough (each 6-foot section)	2
Wash sink (circular or multiple each set of faucets	2
Water closet, tank-operated	4
Water closet, valve-operated	6
Fixtures not listed above:	
Trap size 1-1/4" or less	1
Trap size 1-1/2"	2
Trap size 2"	3
Trap size 2-1/2"	4
Trap size 3"	5
Trap size 4"	6

(2) Assume that the cast-iron house drain to be installed will have a slope of 1/4-inch per foot.

From table 3-3 it may be seen that the minimum size pipes for the horizontal sanitary drainage system under discussion is 5 inches. Table 3-3 is for cast-iron soil pipe or galvanized steel pipe house drains, house sewers, and waste and soil branches. When copper tubing is used, it may be one size smaller than indicated in the table. It [illegible] good to note that the size of building drainage lines must never decrease in the direction of flow

Table 3-3. Maxiumn loads for horizontal drains

Diameter of drain	Horizontal Fixture Branch	Building drain or building sewer Slope			
		1/16 in./ft	1/8 in./ft	1/4 in./ft	1/2 in./ft
(in.)	(d.f.u.)[1]	(d.f.u.)	(d.f.u.)	(d.f.u.)	(d.f.u.)
1-1/4	1				
1-1/2	3				
2	6				26
2-1/2	12			24	31
3	32[2]		36[3]	42[2]	50[2]
4	160		180	216	250
5	360		390	480	575
6	620		700	840	1000
8	1400	1400	1600	1920	2300
10	2500	2500	2900	3500	4200
12	3900	3900	4600	5600	6700
15	7000	7000	8300	10000	12000

[1] Drainage fixture unit.

[2] Not more than two water closets or two bathroom groups.

[3] Less than 2 feet per second.

When provision is made for the future installation of fixtures, those provisions must be considered in determining the required sizes of drain pipes. Construction to provide for such future installation should be terminated with a plugged fitting or fitting at the stack to eliminate any dead ends.

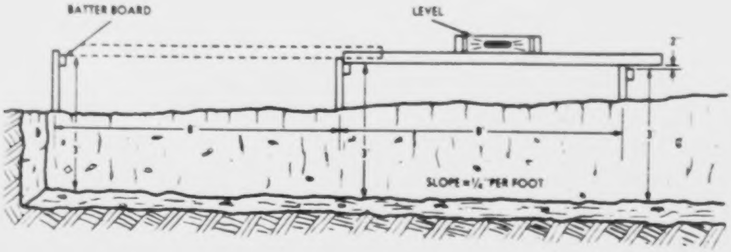


Fig 3-3. Grading the house sewer.

Whenever possible, trenches used for building sewers and drains should be graded (fig 3-3) to a slope of 1/4 inch per foot. Lesser or greater slopes are permissible when circumstances requires them. Trenches for building sewers may be graded with surveying instruments or by the batterboard method. For trenching, it is convenient to place the batterboards at 8-foot (2.44 meters) intervals. Each batterboard consists of a stake with a block of wood nailed 2 inches (5.08 centimeters) below the top. After setting the first one with the top of the block at a convenient distance above the proposed bottom of the trench, succeeding batterboards are driven so that the top of the stake of each one is level with the top of the block on the preceding one. This level is established with a carpenter's level and a board over 8 feet long placed on the block of one batterboard and on top of the stack of the succeeding one. The trench is always dug to the same depth. This depth is below the line established by the tops of the blocks. Since the batterboards are 8 feet apart and each is 2 inches lower than the one preceding it, the line has a slope of 1/4 inch per foot. The same method may be used for other slopes. For example, setting the blocks 1 inch (2.54 centimeters) below the top of the stakes would give a slope of 1/8 inch per foot; 4 inches would give a slope of 1/2 inch per foot.

As soon as the trench is dug and graded, your next step is to connect the house sewer to the main. The most common procedure for installing the building sewer is to connect the sewer thimble to the street sewer and work back, grading upwards, to the house drain. First, find the flow level of the main sewer. This can be done by tapping it lightly with a hammer. The point at which the blow sounds different will be the sewage level. The sewer thimble must be tapped in above this flow (fig 3-4). Next, with a cold chisel and hammer, carefully cut a small hole in the center of the proposed location of the sewer thimble. The main sewer is usually constructed with vitrified clay pipe; therefore, care must be taken during the cutting. Enlarge the hole into an oval shape as close to the shape of the sewer thimble as possible. The sewer thimble should fit tightly into the hole with its discharge parallel to the direction of flow in the hole, a ring of oakum is packed around it. Then, cement mortar is packed in the joint, and the joint is braced until the mortar sets.

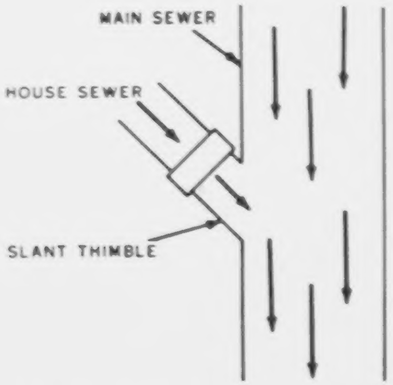


Fig 3-4. Correct installation of a sewer thimble.

Building sewer and drain piping may be supported adequately by laying it on a base of solid undisturbed earth. This will eliminate future settling which might bring the weight of the pipe sections to bear on the joints. Where the support furnished by the trench is doubtful, each joint should be supported on concrete, cinder block, or brick.

Note: To insure proper drainage, keep lines unobstructed.

You learned earlier that the building drain is that part of the plumbing system under the building which receives the discharge from the soil and waste stacks and carries it to the building sewer, and you learned how to determine the proper size of drain and how to install it. Continue to studing this system, we shall now turn our attention to stacks and vents.

The stack is the vertical assembly of soil or waste piping into which the soil or waste branches convey the discharge from fixtures to the house drain. A waste stack conveys liquid wastes that do not contain human excrement; a soil stack conveys liquid wastes that do. Most buildings do not have separate soil and waste stacks; a single stack known as the soil and waste stack, or simply the soil stack, serves to carry both soil and waste material. Soil stacks are usually made of cast-iron pipe with caulk joints. They may, however, be made of other materials such as galvanized steel or copper tubing. Branches are usually either threaded galvanized steel pipe with drainage (recessed) fittings or copper tubing. Figure 3-5 shows a stack installation.

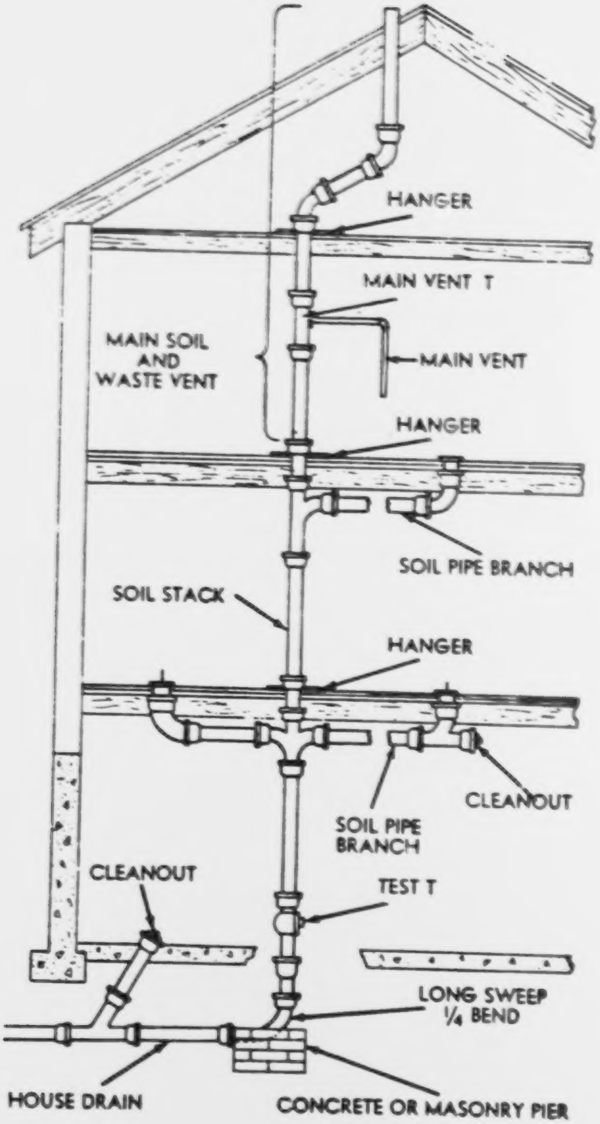


Fig 3-5. Soil stack and branches.

The term "stack" is used to identify the vertical main pipe in a plumbing waste system. A particular stack may be further defined by the function it performs in the system.

- A soil stack is the vertical main pipe that carries human excrement to a junction with a soil pipe or to the building drain, as shown in figure 3-5. The plumbing codes specify that a soil stack must be constructed of pipe with a minimum diameter of 3 inches.

- A waste stack is the vertical pipe that carries waste from any fixture, except water closets, to a junction with the soil pipe or to the building drain, as shown in figure 3-5. Waste stacks may be as small as 2 inches in diameter; the size of the pipe is determined by the number and type of fixtures connected to the stack.

- Vent stacks are vertical pipes which provides circulation of air through the drainage system. The vent stack may be constructed on top of a soil stack, but only the portion of the pipe which is above the highest fixture rim or waste branch inlet is considered to be the vent stack, as you can see in figure 3-5.

The stack is sized in the same way as the building sewer. The maximum discharge of the plumbing installation is calculated in drainage fixture units (d.f.u.) which are then applied to figure 3-6 to obtain the proper stack size. Continuing the preceding example, the 270 drainage fixture units would require a 4-inch stack, if the stack had less than three branch intervals. The minimum size of pipe used in a stack should be 3 inches in diameter; however, a pipe 4 inches in diameter is preferred. No soil or waste stack should be smaller than the largest horizontal branch connected, except that a 4 x 3 water closet connection should not be considered as a reduction in pipe size. A stack may decrease in size (not less than 3 inches) but may not increase over the building drain size.

Size of pipe (inches)	Fixture units per stack
3	60
4	500
5	1,100
6	1,900
8	3,600
10	5,600
12	8,400

Fig 3-6. Maximum fixture units per stack.

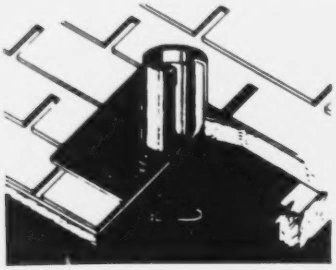


Fig 3-7. Installed flashing.

Notice in figure 3-5 that the stack is started with a long sweep 1/4 bend. (The long sweep allows a smoother change of direction for the flow of wastes.) The stack then goes through the basement where a test tee is installed 12 inches (27.48 centimeters) above the finished floor. The stack then continues up to the point where it intercepts the first floor branches. A double 90° Y-branch is used to connect branch lines from both sides. Next, a short piece of cast-iron soil pipe is caulked in just enough so the hub clears the first floor. At this point, a hanger or brace is put between the floor and the hub. This tends to hold the stack from settling. If there is more than one floor, this procedure is repeated as shown in figure 3-5. The stack is continued until it reaches a point 6 inches (15.30 centimeters) above the flood level of the highest fixture. Here a T is installed. It is sometimes referred to as the main vent T. The stack is then continued through the roof. It should extend at least 12 inches above the roof. The hole around the pipe is waterproofed by using some sort of flashing as shown in figure 3-7. In certain areas of the country, it is possible for frost to close the vent at the roof outlet when the vent is exposed to temperatures below freezing. The air within the stack and vent pipes in the building is usually very close to the moisture saturation point. When this very humid air is emitted from the main and waste vent, it condenses and freezes if it is exposed to extremely cold temperatures. One way to prevent frost from closing the vent is to increase the pipe to a size or two larger than the vertical stack. Another method that can be used in extremely cold climates is to install a high lead flashing which provides an insulating pocket of air between the flashing and the end of the main and waste vent above the roof. This air pocket is open to the heat of the building and provides an intermediate warming area for gases leaving the main soil and waste vent.

Note: The stack is always installed in the shortest run possible and should be kept unobstructed. This rule should always be followed.

Branches are soil pipes that run horizontally from the fixtures to the stack. A branch is sized in the same manner as the house drain. Using table 3-2, determine the fixture units and apply them to table 3-3 for the correct size of soil pipe.

A branch (fig 3-5) is connected to the stack with a 90° Y-branch and is run slightly uphill to the farthest fixture. It should have a 1/4 inch per foot drop slope as it falls to the stack. At the end of each branch, a cleanout is installed. The branch lines should be supported every 5 feet (1.52 meters).

Vents are pipes or openings which introduce outside air into the plumbing system and equalize the pressure at both ends of the trap. The main purpose of ventilation is to provide an opening to the atmosphere on the discharge side of a trap which will prevent a loss of the water seal by siphonage. When the trap water seal is broken, dangerous sewer gases can come up through the fixture into the building. Atmospheric pressure at sea level is approximately 14.7 pounds per square inch. This pressure remains constant on the fixture side of the water seal in a trap. Any difference between this pressure and the pressure on the discharge side of the trap will force the water seal in the direction of least pressure. Venting the discharge side of the trap to the atmosphere will equalize these pressures.

Note: Vent lines must remain unobstructed to work properly.

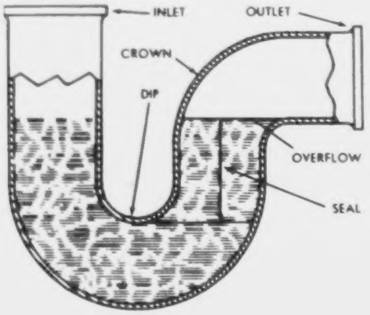


Fig 3-8. Trap seal.

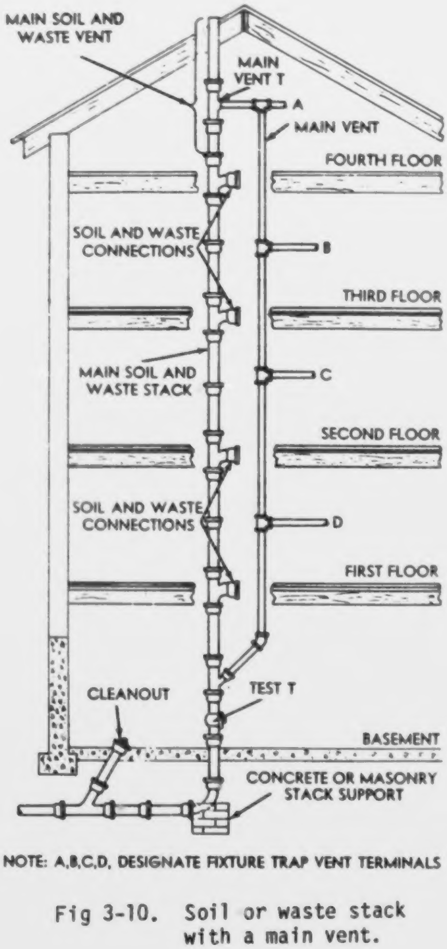
The trap seal (fig 3-8) is the liquid in the U-shaped portion of the trap. The most frequently used trap has a seal depth of 2 inches (5.08 centimeters) between the overflow and the dip. Loss of this seal is usually caused by inadequate venting.

Fixture	Minimum size of vent in inches
Lavatory	1 1/4
Drinking fountain	1 1/4
Sink	1 1/2
Shower	1 1/2
Bathtub	1 1/2
Laundry tub	1 1/2
Slop sink	1 1/2
Water closet	2

Fig 3-9. Individual fixture vent size.

A pipe less than 1 1/4 inches in diameter is too small for ventilation purposes because it could be subject to stoppages at the point where materials flow past it. Figure 3-9 shows the recommended individual fixture vent pipe diameters. The main vent must be at least one-half the size of the stack, but not less than 1 1/4 inches in diameter.

There are basicly five types of vents: main vents, individual vents, wet vents, circuit vents, and unit vents.



NOTE: A,B,C,D, DESIGNATE FIXTURE TRAP VENT TERMINALS

Fig 3-10. Soil or waste stack with a main vent.

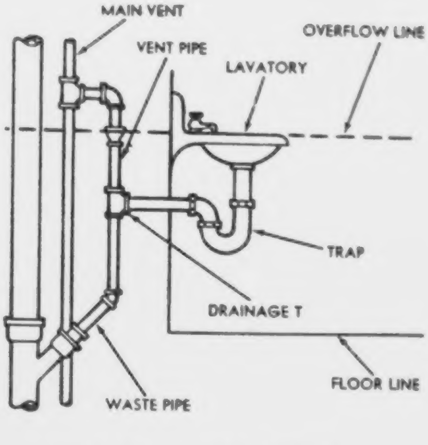


Fig 3-11. Single fixture individually vented.

The main vent (fig 3-10) is a vertical vent pipe that runs parallel to the soil or waste stack and serves as a terminal for the vent piping from the individual fixtures. The main vent is sometimes referred to as the vent stack.

Figure 3-11 shows the installation of a single fixture when a main vent is used (commonly called an individual vent.). Notice that the vent piping rises 6 inches (15.30 centimeters) above the flood level or fixture rim before it ties into the main vent.

Wet vent (fig 3-12) is the portion of pipe through which liquid wastes must flow from another fixture which is itself individually vented.

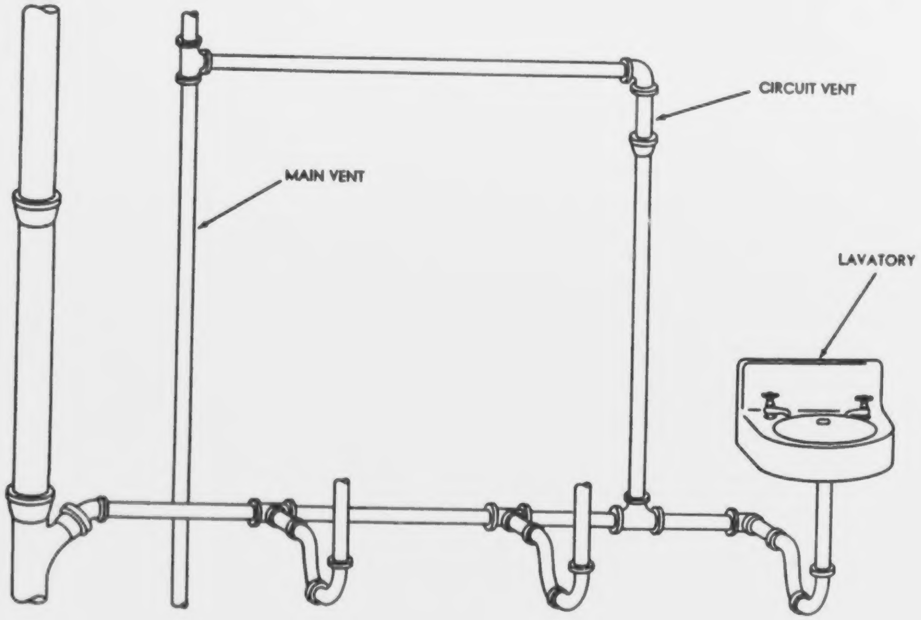


Fig 3-12. Group of fixtures with a wet vent.

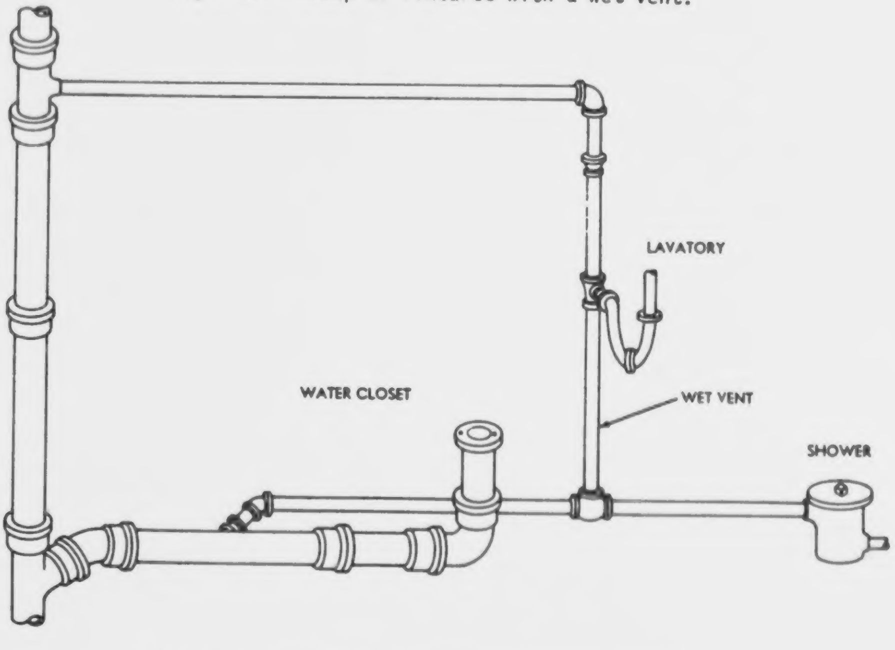


Fig 3-13. Battery of lavatories circuit vented.

Circuit vent (fig 3-13) extends from the main vent to connections on the horizontal soil or waste branch pipe between the fixture connections.

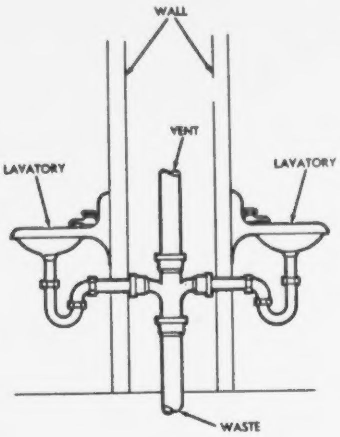


Fig 3-14. Pair of fixtures unit vented.

Unit vent (fig 3-14) are vent pipes installed to protect two fixture traps. The vent pipe may connect to the main vent or extend through the vent.

After the waste installation is completed, it must be tested to see that all joints are watertight. To do this, all branches and vent lines are sealed off, and a test plug is placed in the house drain at the point where it meets the house sewer, usually in the "T" at the base of the stack. The system is then filled with water from the top of the soil and waste stack and is kept filled for about 12 hours to allow the oakum in joints to swell and form a watertight seal. (Galvanized iron or copper tubing installations do not need this 12-hour pretest procedure.) The system is filled with water again and checked for any drop in water level. If the level drops noticeably, each joint is then checked for leaks. If any leaky joints are found, they are repaired by replacing or caulking. The test is satisfactory if the water level does not fall more than 4 inches in a 30-minute period.

The amount of sewage that must be disposed of varies with the number of fixtures and the number of people using the facilities. It is generally considered that the sewage flow for one person will range from 15 to 50 gallons per day. Flows for a person in a hospital range from 50 to 85 gallons per day. This sewage must be treated. In large installations, sewage flows are treated at sewage plants. In smaller installations and in some commercial buildings, the sewage is treated in septic tanks.

A septic tank is generally a watertight container constructed of cement or steel. Waste material from the building sewer feeds into the septic tank where it is acted upon by bacteria. The purpose of the bacteria is to dissolve any solids carried by the sewage. After the solids are dissolved, the effluent waste is usually discharged into subsurface irrigation ditches called leaching fields. The tank capacity of a septic tank for a building should be 2/3 of an average day's flow of sewage. The minimum capacity of a tank should be no less than 500 gallons. Septic tanks usually have an access cover that is used when the sewage sludge which has settled to the bottom needs to be pumped from the tank. Figure 3-15 shows one type of septic tank.

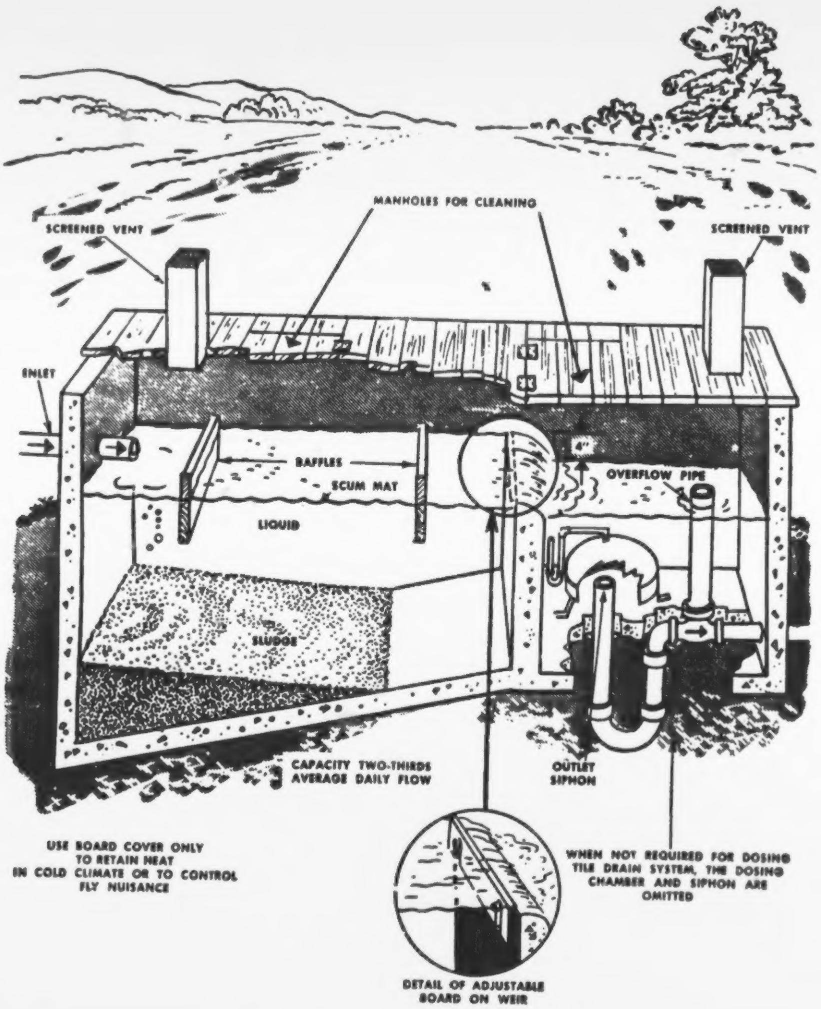

MANHOLES FOR CLEANING
SCREENED VENT
SCREENED VENT
INLET
BAFFLES
SCUM MAT
LIQUID
SLUDGE
4"
OVERFLOW PIPE
CAPACITY TWO-THIRDS AVERAGE DAILY FLOW
OUTLET SIPHON
USE BOARD COVER ONLY TO RETAIN HEAT IN COLD CLIMATE OR TO CONTROL FLY NUISANCE
WHEN NOT REQUIRED FOR DOSING TILE DRAIN SYSTEM, THE DOSING CHAMBER AND SIPHON ARE OMITTED
DETAIL OF ADJUSTABLE BOARD ON WEIR

Fig 3-15. Septic tank.

Before a septic tank can be installed in an area, both the area and the type of installation must conform to local plumbing codes. A septic tank should never be located in a low, wet area, on rock, or in an area that has a lot of tree roots. On residential and commercial sites, the area has to pass a "perc" (percolate) test. This test is performed in the site area to detect how fast the subsoil will absorb water. Like other types of sewage installations, a septic tank should never be placed closer than 100 feet (30.5 meters) to any potable water source.

The maintenance of septic tanks mainly involves the periodic pumping out of waste solids from the tank. If at all possible, only waste coming from toilets should flow directly into a septic tank. Laundry water should be drained into another type of collector. Grease traps should be installed on kitchen waste lines before this water enters the septic tank. Grease, soap, and other chemicals may kill bacteria which are necessary to dissolve solids.

Figure 3-16 shows the general layout of a leaching field. A leaching field is a series of specially laid pipe installed in ditches. The pipe is laid so that the liquid flow from the septic tank enters the field and is absorbed into the surrounding soil. These pipes are made of either a bituminous substance or a vitrified clay material. The bituminous pipe is perforated and has holes bored the length of the line so that water can seep out. Vitrified clay pipe is laid so that a space is left between the joints, allowing water to seep through and be absorbed by the soil.

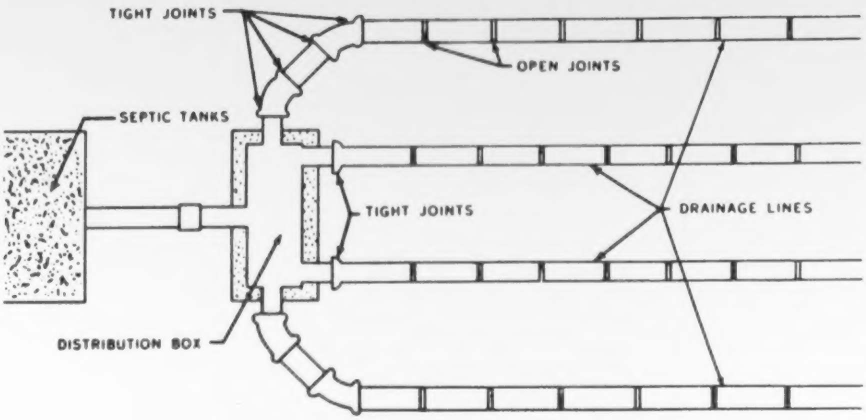


Fig 3-16. Leaching field.

Time for water to fall 1 inch in test hole (minutes)	Average rate of application (gdp per 100 feet of trench 18 inches wide)
1	600
2	480
5	360
10	255
30	120
60	90

Fig 3-17. Application rates of sewage by surface irrigation.

The number of pipes and the length of the leaching field depend on the ability of the soil to absorb water. As was mentioned before, a "perc" test must be made to determine how much water the soil in a specified area will absorb during a given time limit. One way to estimate the absorption ability of the soil is to dig a hole a foot (.3 meters) deep, 1 foot long, and 1 foot wide and fill this hole with water. When the water has seeped into the soil and the bottom of the hole is still wet, pour water to a depth of 6 inches (15.30 centimeters) in the hole and note the time required for the water level to drop 1 inch (2.54 centimeters). Figure 3-17 can be used to determine the rate of sewage application. The area required for the field is determined by the number of lineal feet the field requires. You can run this in two, three, or as many rows as necessary. Most codes specify a 6 foot (1.83 meter) minimum spacing between rows.

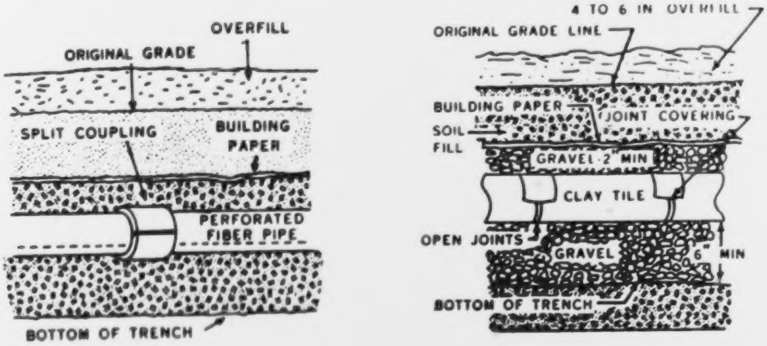


Fig 3-18. Installation of perforated fiber pipe and open joint clay tile pipe.

Trenches for the leaching field usually have a width of 18 inches (45.72 centimeters) and depth that permits 6 inches (15.24 centimeters) of gravel on the bottom (fig 3-19). Be sure this depth is below the frost line.

The perforated pipe should be placed in the trench (holes facing downward) at a slope that follows the plumbing code specifications for that area. This slop can range from 2 to 4 inches per 100 feet of pipe. When the pipe has been placed in the trench at the correct slope, 2 to 4 inches of gravel should be laid on top of the pipe. To keep backfilling dirt out of the drain, a suitable material such as tarpaper should be placed on the gravel. As a final step, the trench should be backfilled with soil to a level of approximately 4 to 6 inches over the original grade.

Leaching fields which are properly designed and installed require little maintenance. When maintenance is required, it usually involves the removal of roots that have grown into the pipe and have cause stoppages or the clearance of a cave-in. If a cave-in of one or more trenches does occur, the excess material should be removed and that part of the leaching field replaced.

Grease is one type of waste product that can alter the proper operation of a septic tank. Since grease is usually associated with kitchen wastes, the installation of a grease trap in the kitchen waste line is recommended.

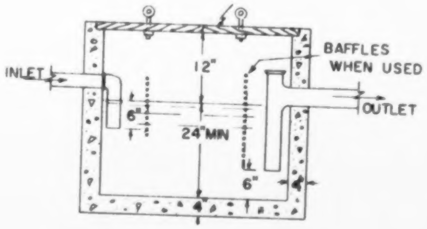


Fig 3-19. Typical grease trap.

A grease trap is a box-like container that can be made of wood, concrete, or metal. This container is placed in the ground in the kitchen or galley waste drain line. A grease trap usually contains an inlet, an outlet, and one or more baffles (fig 3-19). These parts are situated so that as the waste water enters the trap through the inlet, the grease separates from the liquid and floats to the top. (Grease is less dense than water.) The liquid then drains through the outlet, and the grease is retained within the trap. The baffles restrict any unnecessary water flow within the tank that could prevent the separation of the grease from the liquid. The trap must be periodically cleaned to remove accumulated grease.

The grease trap should be placed as close to the building drain as possible. This minimizes grease buildup in the waste pipes. As with commercial plumbing applications, the installation of a grease trap must conform to local plumbing codes. Field installations of grease traps will be discussed in work unit 3-2 dealing with field expedients.

When properly installed, a grease trap will need little maintenance. If maintenance is required, it usually involves cleaning the trap to remove grease that has collected there.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. The building sewer is that part of the plumbing waste system which extends from the street sewer line to the ____________________

2. What part of the plumbing system receives the discharge of the soil and waste stacks?

    ____

3. Although there is no maximum size for the diameter of cast iron soil pipe used for a building sewer, the minimum is ____________ inches.

4. Although a building drain or sewer is sloped according to fixture units of waste it will carry, the preferred slope in installation per foot is _____________ inch.

5. To insure proper removal of waste from the building, you should insure the building sewer and drain are kept ____

6. The vertical run of soil pipe in a building is called the ______________________

7. The stack pipe size should never be less than ____________inches.

8. The rule, install in the shortest run possible, refers to the installation of ____

9. How far above the roof line should a vertical run of soil pipe extend?

____

10. Maintenance of a stack is mainly involved with keeping it ______________________

11. What is the proper slope for installing branch lines?

____

12. The traps in a waste system keep their trap seal because venting

____

13. The individual, the unit, and the circuit are types of vents. What is another type?

____

14. A vent pipe should be at least _______________________ inches in diameter.

15. Vent lines should be support at least every _____________________ feet.

16. What should be installed at the end of each branch?

____

17. To insure proper venting of the traps, the vent lines should periodically be checked for

____

18. What changes the composition of the solid wastes in a septic tank?

____

19. The installation of a septic tank must conform to ______________________________

____

20. What is the minimum distance a septic tank should be placed from a potable water source?

____

21. Sometimes the maintenance of a septic tank requires that it be _________________

____

22. The purpose of a leaching field is to accept the flow of liquid from a septic tank and____

23. The pipes used in a leaching field ____

24. The most important consideration in the installation of a leaching field would be the ______________________________

25. Which type of test is used to determine the ability of the soil to absorb water?

____

26. If a leaching field is properly installed, probably the only maintenance involved would be the removal of tree roots and the ______________________________

____

27. The purpose of a grease trap in a plumbing system is to ______________________________

____

28. The reason that a grease trap works the way it does is simply because grease ______

____

29. A grease trap should be installed as close to the building drain as possible. Why is this so?

____

____

30. The major maintenance involved with grease traps would be the ______________________________

____

Work Unit 3-2. FIELD EXPEDIENTS

IDENTIFY THE MOST IMPORTANT RULE OF THUMB CONCERNING THE CONSTRUCTION OF FIELD EXPEDIENT DRAINS.

LIST THREE GENERAL TYPES OF FIELD EXPEDIENT DRAINS.

STATE THE MAINTENANCE INVOLVED FOR FIELD EXPEDIENT GREASE TRAPS.

In the previous study unit, some types of field expedients (heads, urinals, etc.) were discussed. You should remember that a field expedient installation is a temporary measure used when more permanent facilities are not available. A field expedient may be constructed in any form as long as it accomplishes the intended job. Usually field expedients are constructed of the most readily available material.

The types of field expedient drains that can be used by the Marine plumber are as varied as his imagination and know-how. A field expedient drain can be constructed in any form which permits the satisfactory removal of waste from a certain area. Sanitation should be the important consideration in the removal process. Some types of field expedient drains will be covered below.

The most basic type of drain used in the field is the open ditch. This type of expedient can be used to drain water away from a mess kitchen or from a shower. The open ditch is usually the first type used when a unit moves into a new area. The open ditch should be used only until a better system can be installed because it is a breeding ground for insects, bacteria, and odors. The open ditch should not drain into any potable water source and should be at least 100 feet (30.5 meters) from any well. This type of drain can be used with some success where the soil is absorbent.

Pipe can be used as a means of expedient drainage if it is of an adequate size to handle the waste water volume of an area. Any type of pipe (copper, plastic, etc.) can be used as long as it can handle the anticipated volume of waste water. Pipe can direct the flow of water to soakage pits, drain beds, or leaching fields. Remember, use caution when disposing of waste water in the drainage area if located near a potable water source.

Rigid hose (when obtainable) is very easy to use and can handle all types of expedient drainage. Types of rigid rubber-lined hose, such as unserviceable fuel hoses or water hoses, can be used for drainage purposes. This hose usually comes in 4-inch diameter sizes and 10 foot (3.05 meters) and 20 foot lengths. Certain precautions should be taken if there is a possibility of the hose being run over by heavy vehicles. (Rigid hose will collapse under heavy loads.) In areas where contact with heavy vehicles is common, rigid hose should be buried in ditches for protection.

The construction and installation of expedient drains are dependent on the imagination and versatility of the Marine plumber. Anything that will work and still comply with applicable sanitation requirements can be used. A field expedient drain can be constructed or installed in any way that accomplishes the intended job.

When there is a possibility that waste water may contain grease, a grease trap should be used. The elimination of grease, even in the field, reduces drainage problems. Grease not only clogs pipe perforations, pipe inlets, and the inside of the pipe itself, but is also a source of odor and harmful bacteria.

A grease trap is a watertight container constructed of sufficient size to handle a specific waste water volume and baffled to slow the entrance and exit of water. The trap must contain enough cool water so that when the warm greasy liquid enters the trap, the grease will start to congeal. This congealed grease must be cleaned (skimmed off) and disposed of often. Disposal methods include burning or burying.

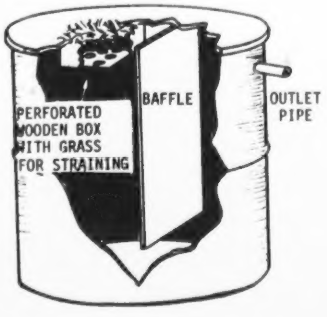


Fig 3-20. Baffle grease trap (drum type).

Two types of grease traps are the baffle grease trap (drum type, fig 3-20) and the baffle grease trap (box type, fig 3-21). Expedient grease traps are not limited to the box or drum types and can take any form which will satisfactorily separate grease from the drain liquid.

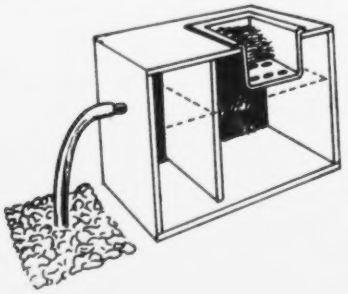


Fig 3-21. Baffle grease trap (box type).

A baffle grease trap may be made from a drum or from a watertight box. The drum or box is divided vertically into an entrance chamber and an exit chamber by attaching a wooden baffle. The baffle should be placed so that the entrance chamber will be approximately twice the size of the exit chamber. The baffle should hang to a point within 1 inch (2.54 centimeters) of the bottom. A strainer which may be made from a small perforated box filled with straw, hay, or burlap is inserted into the lip above the entrance chamber. A pipe is inserted into the exit chamber about 3 to 6 inches below the top as an outlet to the soakage pit. This baffle grease trap is usually placed on the ground at the side of the soakage pit with the outlet pipe extending 1 foot (.3 meters) beneath the surface at the center of the pit. If a grease trap is not watertight, it must be placed partially under the ground.

Before the grease trap is used, the chambers are filled with cool water. The waste liquid is poured through the strainer which retains solids. As the warm liquid strikes the cool water, the grease rises to the surface of the entrance chamber, and the liquid runs under the baffle, filling the exit chamber. When the liquid reaches the outlet pipe near the top of the exit chamber, it runs through this pipe into the soakage pit. Unless the grease trap is of sufficient capacity, the warm greasy liquid poured into the trap will heat the cool water in the trap, thus allowing the grease to remain uncongealed and pass through the trap. The efficiency of the grease trap can be increased by constructing it with multiple baffles. Also, a series of traps may be used.

The baffle grease trap must be properly maintained to prevent clogging of the soakage pit. The grease retained in the trap should be skimmed from the surface of the water daily or as often as required and either buried or burned. The entire trap should be emptied and thoroughly scrubbed with hot, soapy water as often as necessary.

An expedient leaching field is any type of installation which satisfactorily allows the leaching of liquids from a sewage system. The installation of an expedient leaching field can include such previously discussed methods for sewage disposal as soakage pits, trenches, space-jointed pipe/hose, and perforated pipe/hose. Remember that leaching fields should be placed in an area that can absorb water satisfactorily and is at least 100 feet (30.5 meters) from any potable water source.

EXERCISE: Answer the following questions and check your responses against those listed at the end of this study unit.

1. In general, the most important rule of thumb concerning the construction of field expedient drains is that

   a. they may be constructed in any form which permits the sanitary removal of waste.
   b. they must be used only in garrison conditions.
   c. they may be used only when all else fails.
   d. the plumber should use plumbing materials only.

2. List three types of field expedient drains.

   a. ______________________________

   b. ______________________________

   c. ______________________________

3. The baffle grease trap must be properly maintained to prevent ______________ ______________________________________

SUMMARY REVIEW

In this study unit, you have learned how to install and maintain a permanent and field expedient sewage system, including the associated components of the systems.

Answers to Study Unit #3 Exercises

Work Unit 3-1.

1. building drain line.
2. Building drain
3. 4
4. 1/4
5. unobstructed.
6. stack.
7. 3 inches.
8. building stacks.
9. 12 inches.
10. unobstructed.

11. 1/4 inch drop per foot
12. keeps the pressure in the system equalized.
13. Wet
14. 1-1/4
15. 10
16. Cleanout
17. obstructions.
18. Bacteria
19. the topographic survey.
20. 100 feet
21. pumped out periodically.
22. adequately absorb it.
23. are perforated.
24. ability of the soil to absorb water.
25. "Perc"
26. repair of cave-ins.
27. separate grease from other liquids.
28. is less dense than water.
29. This minimizes grease buildup in the waste line.
30. periodic cleaning out of grease solids.

Work Unit 3-2.

1. a
2. a. Open ditch
   b. Pipe
   c. Rigid hose
3. clogging of the soakage pit

PLUMBING AND SEWAGE DISPOSAL

REVIEW LESSON

INSTRUCTIONS: This review lesson is designed to aid you in preparing for your final exam. You should try to complete this lesson without the aid of reference materials, but if you do not know an answer, look it up and remember what it is. The enclosed answer sheet must be filled out according to the instructions on its reverse side and mailed to MCI using the envelope provided. The questions you miss will be listed with references on a feedback sheet (MCI-R69) which will be mailed to your commanding officer with your final exam. You should study the reference material for the questions you missed before taking the final exam.

A. Multiple Choice: Select the ONE answer that BEST completes the statement or answers the question. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

1. As a Marine plumber, one of the reasons that you will not often use iron pipe is

    a. it can not be aquired by the Marine Corps.
    b. it can be difficult to join in tight places.
    c. it is no longer being manufactured.
    d. the Marine corps no longer has the tools that are used to install this pipe.

2. Iron pipe is quired by the Marine Corps either threaded or unthreaded, in _______ feet lengths only.

    a. 10
    b. 21
    c. 25
    d. 50

3. Identify the means by which the size of iron pipe is measured.

    a. Outside diameter (O.D.)
    b. Inside diameter (I.D.)
    c. Specific types
    d. Specific applications

4. Iron pipe has long been used in application that requires

    a. weight and pressure.
    b. concrete and weight.
    c. strength and durability.
    d. strength and ability to be used in tight places.

5. What are the three weights of iron pipe?

    a. Light, standard and extra heavy
    b. Light, medium and heavy
    c. Standard, medium and extra heavy
    d. Standard, extra heavy and double extra heavy

6. Which of the following weight of pipe is most often used by the Marine plumber as it is suited for most applications?

    a. Light
    b. Medium
    c. Standard
    d. Heavy

7. To obtain a clean, even, flat cut, the pipe to be cut must be anchored firmly by a(n)

    a. die stock.
    b. threaded fitting.
    c. coat hanger.
    d. pipe vise.

8. Once you have measured and cut a section of pipe, what must you remove prior to threading the pipe?

    a. Burrs
    b. Dents
    c. Excess dirt
    d. Excess oil

9. Identify the two main components of the pipe threaded.

a. Handle and ratchet
b. Die and die stock
c. Die stock and ratchet
d. Die and ratchet

10. Which of the following is used to lubricate the die during the threading process?

a. Oil that does not contain sulfur
b. OE 10w40
c. Cutting oil
d. Motor oil

11. What must be applied to all male threads prior to screwing them into a fitting?

a. Lubricating oil
b. Cutting oil
c. Pipe oil
d. Pipe dope

12. What are the two types of pipe dopes used by plumbers to join a pipe to a fitting?

a. Vinyl tape and compound
b. Compound and friction tape
c. Electrical tape and friction tape
d. Cement and glue

13. What is the smallest size pipe wrench that you should use on a 2-inch pipe to join a section of pipe to a 2-inch fitting?

a. 10 inch
b. 12 inch
c. 14 inch
d. 18 inch

14. What type of wrench is ideal when working in tight quarters, with a large diameter pipe?

a. Stilson wrench
b. Hex wrench
c. Chain wrench
d. Pipe wrench

15. What type of threaded fitting would you use in a plumbing installation if you expected to undo or disconnect a portion of the pipe at a future date?

a. Union
b. Elbow
c. Nipple
d. Coupling

16. The gate, globe, angle, and check valves have their own special function within a plumbing system. The three main functions of a valve are to shut off the flow, direct the flow, and

a. increase the pressure.
b. decrease the pressure.
c. regulate the flow.
d. stop the flow.

17. Traps are plumbing fixtures designed to trap or block sewer gases from entering the house or building by providing a(n)

a. bend in the run.
b. liquid seal between the fixture and the source of the gas.
c. place for foreign objects to get stuck.
d. air gap between the fixture and the source of the gases.

18. The three most common traps that you will come into contact with are the

a. P-trap, drum trap, and U-trap.
b. S-trap, U-trap, and drum trap.
c. Drum trap, P-trap, and S-trap.
d. U-trap, S-trap, and P-trap.

19. What is the largest diameter of PVC and ABS plastic pipe that you will encounter?

a. 6 inch I.D.
b. 8 inch I.D.
c. 10 inch I.D.
d. 12 inch I.D.

20. Identify an advantage in using plastic pipe for a plumbing installation.

a. Poor selection of sizes
b. Low initial cost
c. Sandwiching rectifier
d. Low resistance to impact

21. Which of the following is a disadvantage in using plastic pipe?

a. Rapid installation
b. Light weight
c. Corrosion resistance
d. Low resistance to impact

22. When cutting plastic pipe with a hand saw, it is recommended that you use a cutting guide such as a(n)

a. short piece of iron pipe.
b. precut piece of wood.
c. miter box.
d. junction box.

23. Identify, from the following, the method most often used by Marine Corps plumbers to join plastic pipe.

a. Hot gas weld method
b. Threaded fitting method
c. Adhesive method
d. Coupling method

24. Plastic valves and fitting can be requested either____________ or ____________ depending on the type of plastic pipe being installed.

a. quick or snap connection
b. threaded or unthreaded
c. flexible and rigid
d. flexible or threaded

25. Plastic pipe, valves, and fittings are used in the hot and cold water systems as well as in

a. hydraulic systems.
b. high temperature systems.
c. high pressure systems.
d. drain and sewage systems.

26. Prior to the intervention of copper and plastic piping, cast iron soil pipe and fittings were primarily used in the

a. waste system.
b. supply system.
c. hot and cold water system.
d. run off system.

27. As a Marine plumber, what are the three sizes (inside diameters) of standard or service weight soil pipes and fittings that are available to you?

a. 2", 4", and 6"
b. 4", 6", and 8"
c. 2", 3", and 4"
d. 2", 6", and 10"

28. A hammer and cold chisel, pipecutter and a ____________ may be used to cut cast iron soil pipe.

a. handsaw
b. hacksaw
c. sabre saw
d. jig saw

29. When cutting cast iron soil pipe, which of the following methods requires the use of a board or mound of earth to support the pipe?

a. Pipe cutter method
b. Hammer and cold chisel method
c. Jig saw method
d. Hacksaw method

30. The common types of cast iron fitting that you will work with are and

a. bends, branches, and formats.
b. bends, branches, and reducer adapter.
c. bends, branches, and compression unions.
d. bends, branches and tees.

31. Copper pipe and tubing are used in all types of installations for

a. hot and cold water distribution systems.
b. hot water distribution systems only.
c. cold water distribution systems only.
d. waste drain systems only.

B. Identification: Identify the following characteristic as being either an advantage or disadvantage.

Value: 1 point each

32. Installation procedures	a. Advantage
33. Cost	b. Disadvantage
34. Weight	
35. Resistance to damage	

36. Flexible copper tubing is available in

a. lengths of 12 and 20 feet.
b. coils of 25 and 50 feet.
c. lengths of 10 and 20 feet.
d. coils of 40 and 100 feet.

37. When cutting and bending copper tubing, the tubing bender, the copper tubing cutter and the ____________ should be used.

a. hammer and chisel
b. carpenders saw
c. hacksaw
d. coping saw

38. When measuring copper tubing prior to cutting it, you should consider the

a. size of the fitting.
b. width of the tubing.
c. distance that the tubing will be inserted into the tubing.
d. distance that the tubing will extend out of the fitting.

39. As a Marine plumber, you determine that the water service line is 2-1/2 inches. This would indicate that the main supply line is

a. 10 inches.
b. 5 inches.
c. 4-1/2 inches.
d. 2-1/2 inches.

40. The water service line must be of adequate size to supply potable water to all

a. buildings in the area.
b. street mains.
c. water lines.
d. fixtures.

41. Two of the most important factors to consider when sizing the water service line are the maximum fixture demand and the

a. size of the street main.
b. factor of simultaneous use.
c. size of wrench that are available.
d. number of fittings used.

42. For practical purposes, what percentage of all fixtures will be used simultaneously?

a. 75%
b. 50%
c. 40%
d. 30%

43. In the installation of a water closet, what is the most important part of the installation?

a. Insuring a watertight and gastight seal
b. Insuring that putty is applied
c. Overtighten the closet bolts
d. Installing the closet bolts

44. In the event that a force up plunger fails to clear a stoppage in a water closet, the next step would be to use a closet auger or a(n)

a. closet coiler.
b. wire brush.
c. snake.
d. large wire rope.

45. The most important aspect of the installation of a urinal is for you to ensure a(n)

a. putty seal.
b. watertight seal.
c. unobstructed drain.
d. proper trap.

46. Two major items involved in the maintenance of urinals are

a. clearing of stoppage and replacing washers.
b. keeping them clean and clearing stoppages.
c. keeping them clean and replacing washers.
d replacing washers and replacing the traps.

47. What is the minimum distance that a faucet should be installed above the overflow of a lavatory?

a. 1 inch
b. 3/4 inch
c. 1/2 inch
d. 1/4 inch

48. The most important requirement in the installation of showers is the absolute _______________ of walls and floors.

a. coloring
b. cleanliness
c. leveling
d. waterproofing

49. What are two types of showers found in Marine installations?

a. Enclosed and flat
b. Room and tub
c. Stall and tub
d. Room and enclosed stall

50. The primary concerns in the maintenance of showers are keeping the drains clean and

a. keeping the tile clean.
b. the clearing of stoppages.
c. polishing the exposed pipes.
d. maintaining hot water.

51. What should be your prime concern when installing a drinking fountain?

a. Its length, width, and height.
b. Its location
c. Sanitation
d. Approximate number of persons who will use it

52. Besides keeping the drain clear and the clearance of stoppages with a force cup or sink snake, what other maintenance action may be required on a water fountain?

a. Adjusting the height of the stream of water leaving the bubbler.
b. The location of refrigerant lines
c. Mounting the fixture on the wall
d. Providing electricity for operation

53. What type of field expedent head is used by Marines who will be staying in an area for 1 to 30 days?

a. "Cat hole"
b. Straddle trench
c. Pit type
d. Drum type

54. To prevent health hazards when using field expident heads, they should be located

a. downstream, down wind, and 100 feet from a well or water source.
b. downstream, down wind, and 25 feet from a well or water source.
c. upstream, down wind, and 250 feet from a well or water source.
d. downstream, up wind, and 100 feet from a well or water source.

55. Keeping a field expident head sanitized is an important and necessary task. This task can be accomplished by

a. chemicals, burning, and or backfilling.
b. chemicals, spraying and or disinfectants.
c. spraying, burning, and or washdown.
d. burning, washdowns and or chemicals.

56. The most important consideration in urinal installation is

a. the type of urinal.
b. drainage.
c. the type of pipes used.
d. the number of Marines who will use it.

57. How often should inlets and funnels of the urinal soakage pit be cleaned and washed?

a. Monthly
b. Weekly
c. Daily
d. Prior to departing the area

58. Which of the following is NOT a procedure to be followed when properly caring for tools?

a. Repair or replace any defective parts of the tool.
b. Store the tools properly
c. Tools stored for long periods of time need not be oiled
d. Keep the tools sharp

59. Identify the two main safety procedures involved with plumbing tools.

a. Proper size and weight
b. Proper selection and brand
c. Proper usage and brand
d. Proper selection and usage

60. When working with propane torches, blowtorches, or acetylene torches, follow instructions that

a. guide you to the task.
b. guide you in lighting, operating, and shutting down the equipment
c. show you where to use them.
d. dictate the cost.

61. A building sewer is that portion of the plumbing waste system which extends form the street sewer line to the

a. next building.
b. building drain line.
c. septic tank.
d. first water closet.

62. Identify the part of the plumbing system that receives the discharge from the soil and waste stacks.

a. Building drain
b. Branches
c. Vents
d. Stacks

63. To insure the proper scouring action takes place within a drain pipe, a water velocity flow of not less than ________________ should be maintained.

a. 2 feet per minute
b. 3 feet per second
c. 2 feet per second
d. 3 feet per minute

64. Building drains or sewers are sloped according to the fixture units of waste they will carry. Therefore, whenever possible, trenches used for building sewers and drains should be graded to a slope of

a. 1/4 inch per foot.
b. 1/2 inch per foot.
c. 3/4 inch per foot.
d. 1 inch per foot.

65. Although there is no maximum size for the diameter of cast iron soil pipe used for drains and sewers a sound practice prescribes a ________ inch pipe.

a. 1
b. 2
c. 3
d. 4

66. To insure proper removal of waste from a building, you should insure the building's sewer and drains are kept

a. safe.
b. sanitary.
c. clean.
d. unobstructed.

67. The vertical assembly of soil or waste piping into which the soil or waste branches convey the discharge from fixtures to the house drain is called the

a. vertical piping.
b. straight run.
c. cummulator.
d. stack.

68. Identify the piping which conveys liquid waste but does not contain human excrement.

a. Waste stack
b. Waste cummulator
c. Soil stack
d. Soil cummulator

69. The vertical pipes which provides for the circulation of air through the drainage system is called the

a. soil stack.
b. waste stack.
c. vent stack.
d. vent cummulator.

70. What is the minimum distance that a stack must extend above the roof for proper ventilation?

a. 4 inches
b. 6 inches
c. 8 inches
d. 12 inches

71. Maintenance of a vent primarily involves keeping it ____________ to prevent a loss of the water seal by siphonage.

a. unobstructed
b. plugged
c. small
d. waterproofed

72. The waste material from a building sewer feeds into a septic tank where it is acted upon by

a. leaching fields.
b. fresh water.
c. bacteria.
d. atomic matter.

73. What is the minimum distance a septic tank should be placed from a potable water source?

a. 50 feet
b. 100 feet
c. 150 feet
d. 200 feet

74. In an area in which the installation of a septic tank is planned what must be performed to determine how fast the subsoil will absorb water?

a. Sewage test
b. Bacteria test
c. AW test
d. "Perc" test

75. Maintenance of septic tanks primarily involves the

a. addition of germs.
b. scum mat cleaned off the top of the water.
c. replacing the board on the weir.
d. periodic pumping out of waste solids from the tank.

76. A leaching field is a series of specially laid pipes installed in ditches so that the

a. liquid flow from the septic tank enters the field and is absorbed into the surrounding soil.
b. soil waste can be pumped out to dry.
c. bacteria can get to the septic tank.
d. liquid flow from the septic tank enters the field and is acted upon by the leaches.

77. What is the main factor to be considered when deciding upon the location of a leaching field?

a. The number of leaches it will take
b. The length of the field
c. The ability of the soil to absorb water
d. The diameter of the bituminous pipe

78. Assuming that a leaching field was properly installed, probably the only maintenance involved would be the removal of tree roots and the

a. replacement of porous pipe.
b. replacement of gravel.
c. repair of cave-ins.
d. replacement of tar paper.

79. What is the purpose of a grease trap?

a. To remove waste
b. To separate grease from the waste water
c. To replace the P-trap on the kitchen sink
d. To reduce the length of the leaching field

80. From the following identify the purpose for installing the grease trap as close to the building drain as is possible.

a. This will minimize the grease buildup in the waste line.
b. To make the trap more accessible for cleaning
c. This saves on the cost of pipe.
d. To obtain better scouring action.

81. The major maintenance involved with grease traps is the

a. addition of detergent to the trap.
b. periodic cleaning out of the grease solids.
c. periodic burning out with gasoline.
d. periodic pumping out of water.

82. Generally speaking, what is the most important rule of thumb concerning the construction of field expident drains?

a. The plumber should use plumbing materials only.
b. Field expident drains may be used only when all else fails.
c. Field expident drains must be used only in garrison conditions.
d. Field expident drains may be constructed in any form which permits the sanitary removal of waste.

83. Pipe and open ditches are two of the three general types of drains. From the following identify the third.

a. Tubing
b. Rigid hose
c. Flex pipe used for vents
d. Rubber cans

84 The baffle grease trap must be properly maintained to prevent

a. clogging of the soakage pit.
b. water from entering the pit.
c. the burlap from rotting.
d. the straw from being burned.

C. Matching: Column 1 contains a list of the various types of joints. Column 2 contains the various method available to join pipe. Match the types of joint in column 1 to the method used to join it in column 2. After the corresponding number on the answer sheet, blacken the appropriate circle.

Value: 1 point each

Column 1

Type of joint

85. Upside down caulked joint
86. Lead wool or shredded lead joint
87. Vertical caulked joint
88. Neoprene gasket joint
89. Horizontal caulked joint

Column 2

Method of joining

a. Melted lead method
b. Cold lead method
c. Compression method

Total Points: 89

* * *

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